Creating Vector-Based Shoreline Coverages from T-Sheets:

A Vectorization Manual

Prepared by the

NOAA Coastal Services Center

Table of Contents

Chapter 1: Introduction to Spatial Data…..………………………………………………..……..3

Chapter 2: About the Software……………………………………….……………………… 8

Chapter 3: Demo: Getting Started……………………………………….………………….....11

Chapter 4: Demo: ArcScan Procedures……..……………………………..………..……....23

Chapter 5: Demo: Adding Attributes………………………………………….……………40

Chapter 6: Procedures to Begin a New Coverage…………………………….………....46

Chapter 7: Plotting Your Maps……………………………………………….…………51

Chapter 1. Introduction to Spatial Data

1A. What is Spatial Data?

Goal: To explain the type and structure of spatial data and its attributes

1B. The Purpose of this Project

Goal: To illustrate the uses of the vector data created by this project

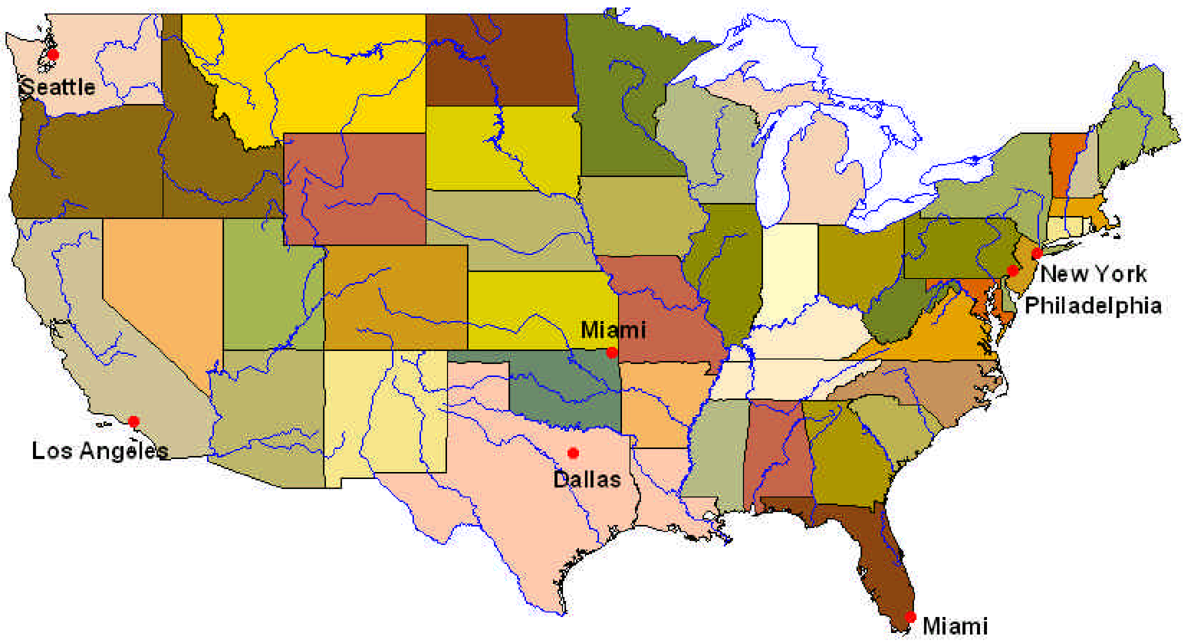
1A. What is Spatial Data?

Spatial data (data concerning the location of things) can be presented as one of three basic types: **points**, **lines**, or **areas**. For example, on a map of the United States seen below,

Cities are represented as **Points.** A point is a single, unique location.

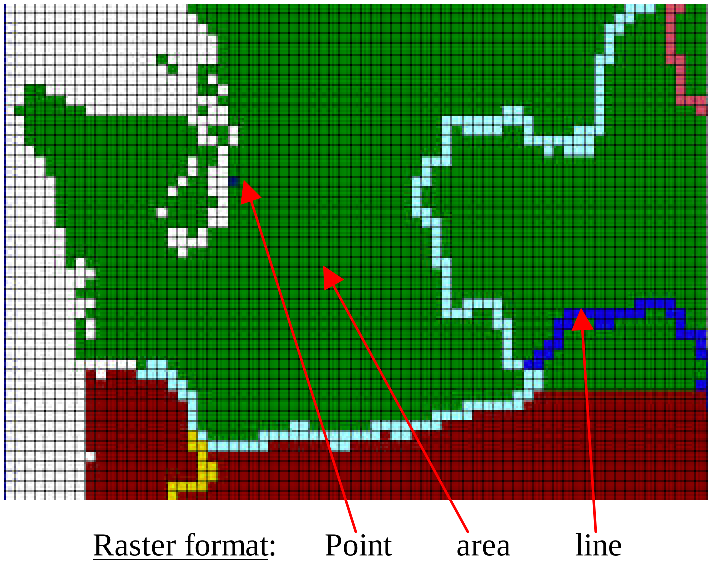
Rivers are represented as **Lines.** A line is a connected series of points having a unique beginning and ending.

States are represented as **Areas.** An area (also called a **polygon**) is a connected series of unique points such that the beginning and ending points are the same. In this way, an area is a "closed" object.

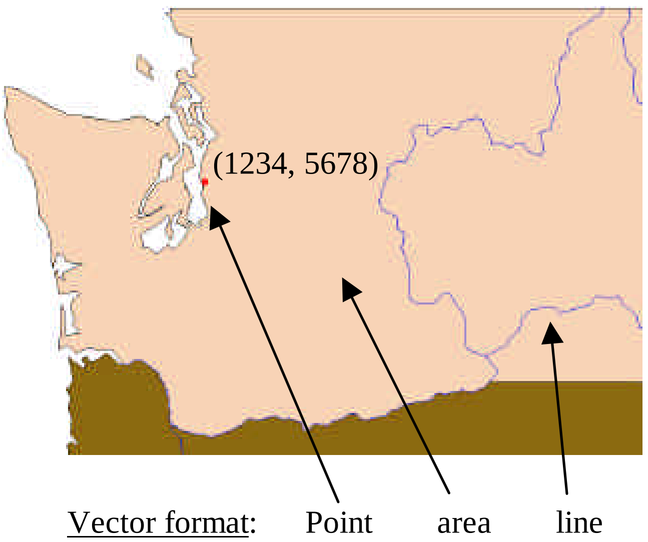


Points, lines, and areas can be represented in two different ways. They can be in a **raster** format or a **vector** format.

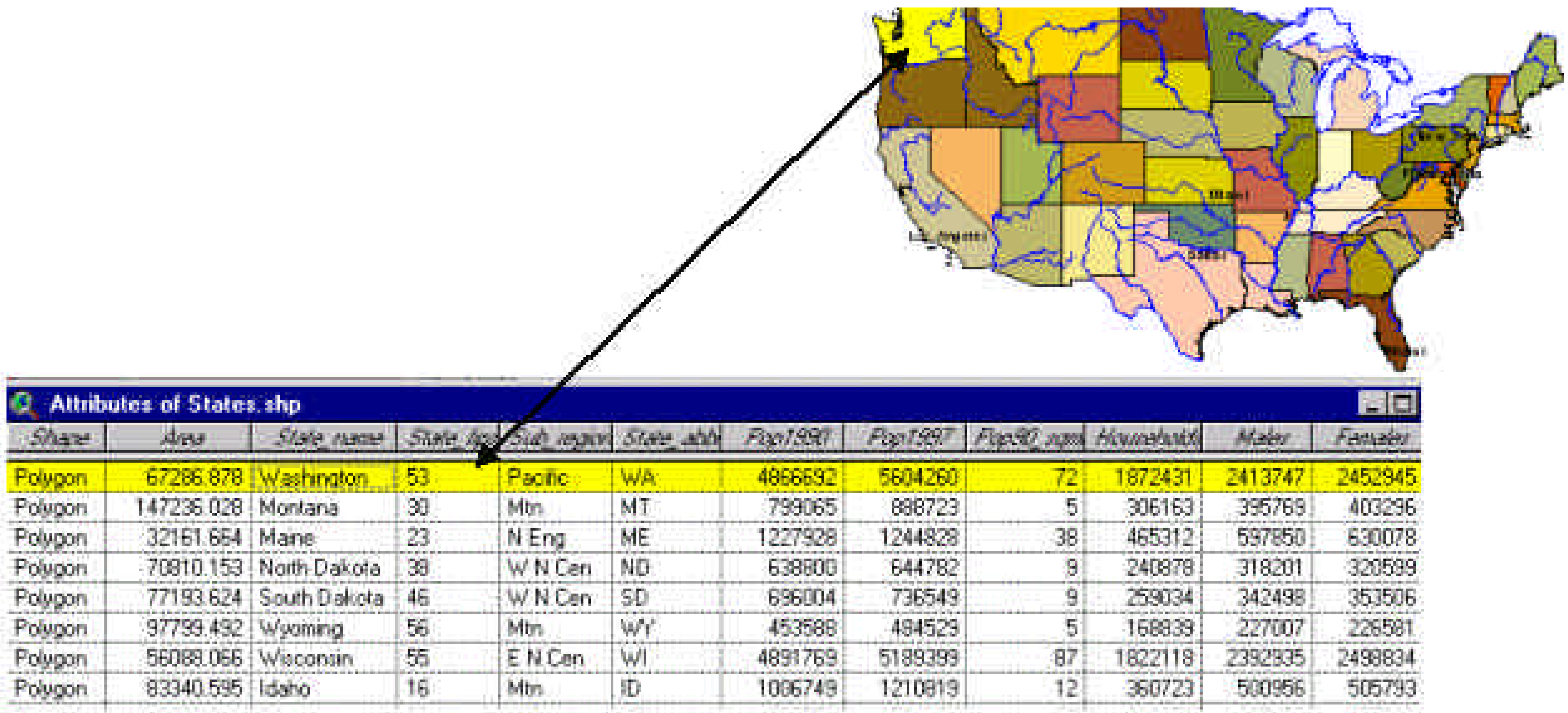
Raster data is made up of a grid of small squares. These squares are often referred to as “cells” or “pixels,” a shortened form of “picture element.” A cell is either “on” to display data, or “off,” displaying no data. Examples of raster data include computer screens and any type of image that was created using a scanner. As a result, raster data often has a “stair-step” effect to it. The degree of this stair-stepping is a result of how large the cells are. The image on the right is a raster image of the states of Washington and Oregon. Note the representation of points, lines, and areas using this grid-based format. Frequently, raster-based data sets will be referred to simply as **grids**.



Vector data is defined by cartesian coordinate pairs. In other words, each point is defined by a specific **x coordinate** (indicating the horizontal location) and **y coordinate** (indicating the vertical location). Some simple examples of vector data are the connect-the-dots children’s games. There, each dot would represent a coordinate location, which can be connected to form lines or areas, or left alone as points. The picture on the lower right is a vector version of the image on the upper right. Note the difference in how the vector data is displayed versus the raster data, particularly in the lack of stair-stepping. Also, since they are coordinate based (illustrated by the point), there is no need for a grid. A vector data set is often called a **coverage**.



An important facet of any data set (regardless of whether it is raster or vector) is the **attribute** information associated with it. Attributes are tabular information that is specifically linked to a given data set. This information is typically set up as a database, which is a searchable collection of data. The purpose of attributes is to give insights into what is going on “behind the scenes” of the spatial data. The graphics below illustrate this concept. In the database file for all of the states, there is information on things such as the spatial data type (point, line, or polygon), its region, abbreviation, population, and assorted census data. By including attributes with spatial data, users can gain information not only on locations, but also on a variety of other topics as well. The amount and content of attribute data is often up to the user to determine based on what a project is trying to address.



Attributes of States.shp

Shape	Area	State_name	State_fip	Sub_region	State_abb	Pop1990	Pop1997	Pop90_sqmi	Households	Males	Females
Polygon	67286.878	Washington	53	Pacific	WA	4866692	5604260	72	1872431	2413747	2452945
Polygon	147236.028	Montana	30	Mtn	MT	799065	888723	5	306163	395769	403296
Polygon	32161.664	Maine	23	N Eng	ME	1227928	1244828	38	465312	597850	630078
Polygon	70810.153	North Dakota	38	W N Cen	ND	638800	644782	9	240878	318201	320599
Polygon	77193.624	South Dakota	46	W N Cen	SD	696004	736549	9	259034	342498	353506
Polygon	97799.492	Wyoming	56	Mtn	WY	453588	484529	5	168839	227007	226581
Polygon	56088.066	Wisconsin	55	E N Cen	WI	4891769	5189399	87	1822118	2392935	2498834
Polygon	83340.595	Idaho	16	Mtn	ID	1006749	1210919	12	360723	500956	505793

The information stored in the database contains a **record** for each state. By highlighting the record for the state of Washington we can see its associated attribute data displayed in a variety of **fields** (e.g., *Shape*, *Area*, *State_Name*, etc.)

1B. The Purpose of this Project

The tasks involved in this project include the following:

- first obtain raster versions of shoreline maps
- then convert them into the vector coverages
- finally add meaningful attribute data for the coverages that are created

A natural question to ask is "What is all of this good for?"

In almost all cases, the data will be used in a geographic information system, or GIS. A GIS is a system designed to store, display, and manipulate spatial data. It is a combination of several different features including

- hardware (computers, plotters, etc.)
- software (the programs used by the computers)
- data (such as the coverages you will be creating)
- an application (a project, such as one of those listed below)
- trained people (perhaps the most important part!)

Creating vector-based digital shoreline maps that can be incorporated into a GIS will be very useful to many in the coastal resource management and planning communities. The resulting data sets will allow them to look at how the shoreline in a particular area has changed over the years, assist in planning oil or chemical spill cleanup activities, help plan for coastal hazard situations such as floods or storms, as well as investigate and answer many other marine resource management issues.

END

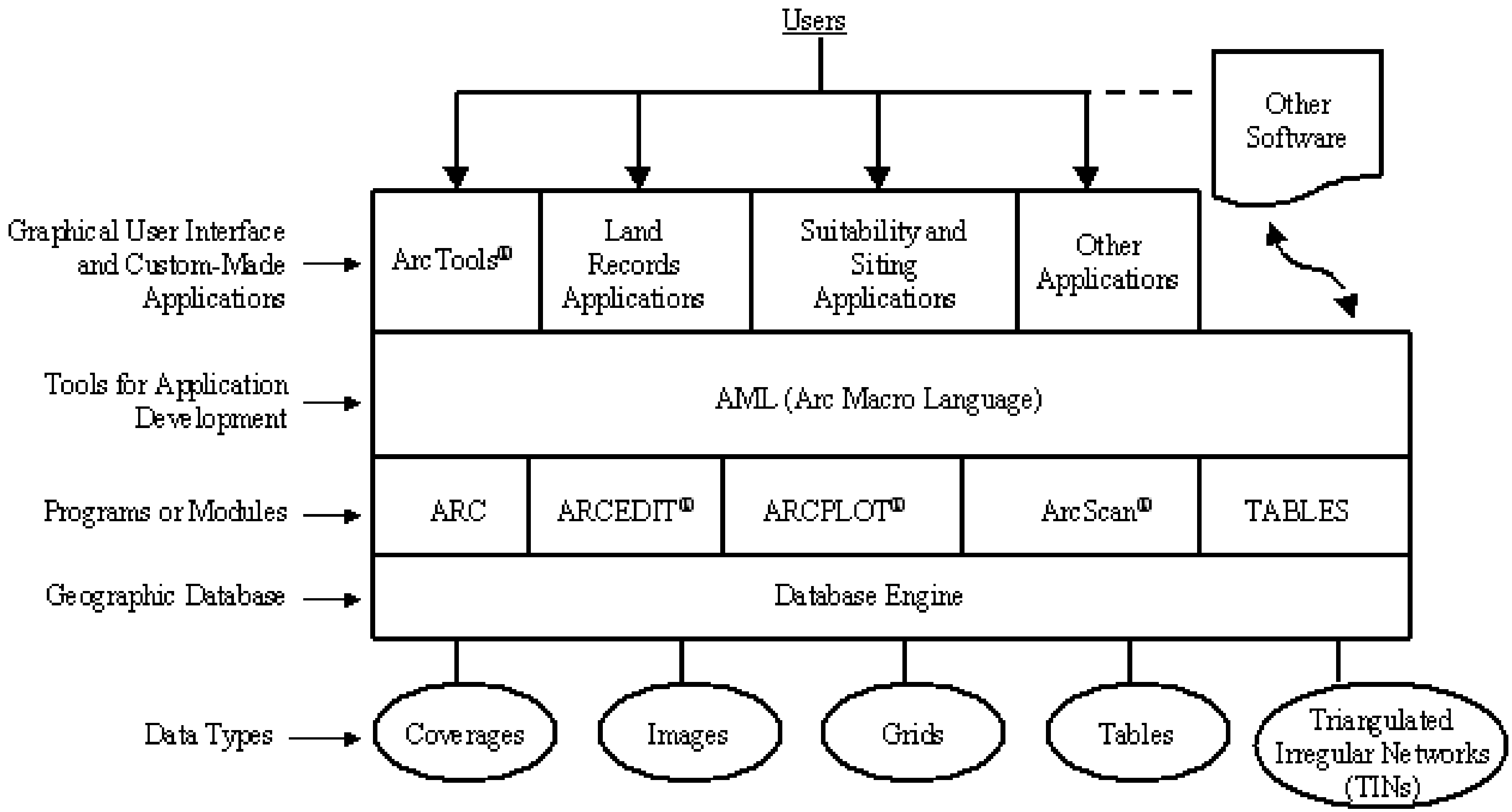
Chapter 2. About the Software

2A. ARC/INFO® for Windows NT

Goal: To provide a brief overview of the ARC/INFO program

2A. ARC/INFO® for Windows NT

ARC/INFO is a GIS software system designed by the Environmental Systems Research Institute, Inc. (ESRI®). It is a complicated mixture of programs, tools, databases, and other items that allow users to perform many tasks. ARC/INFO supports GIS applications in the areas of land resource management, demographic analysis, forestry, environmental analysis, water resource management, mineral exploration, transportation, logistics planning, business planning, cartographic production, and more. The following chart will help to display some of the components and structure of ARC/INFO.



The vectorization project will use the **ArcScan,**® **ARCEDIT,**® and **ARCPLOT**® software programs, also called modules. These modules are accessed and manipulated through the **ArcTools**® graphical user interface (GUI). Each is explained briefly below.

- **ArcScan**: Allows the user to capture (digitize) various graphical features from a computer monitor that exist in a raster format and convert them into a vector format
- **ARCEDIT**: Allows the user to perform various editing tasks to correct mistakes and prepare the final vectorized product
- **ARCPLOT**: Allows the user to generate hard copy maps of the various features that have been digitized

The ARC/INFO software you will be using has been adapted to operate in the Windows NT® environment. This will provide a more familiar setting to work in as opposed to different versions of ARC/INFO that use other computer operating systems.

END

Chapter 3. Demo: Getting Started

3A. Opening ARC/INFO

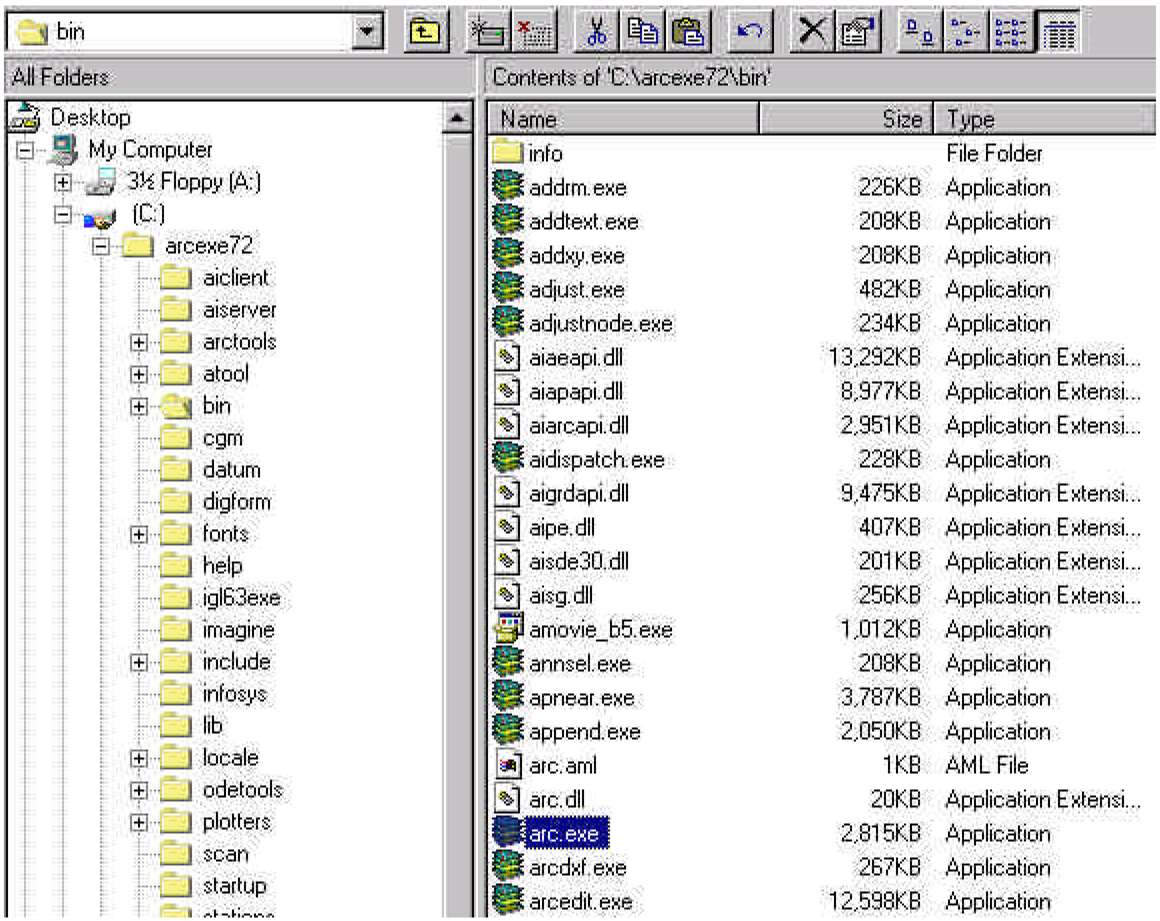
Goal: To provide instruction on accessing and using the ARC/INFO GUI

3B. Preparing ArcTools

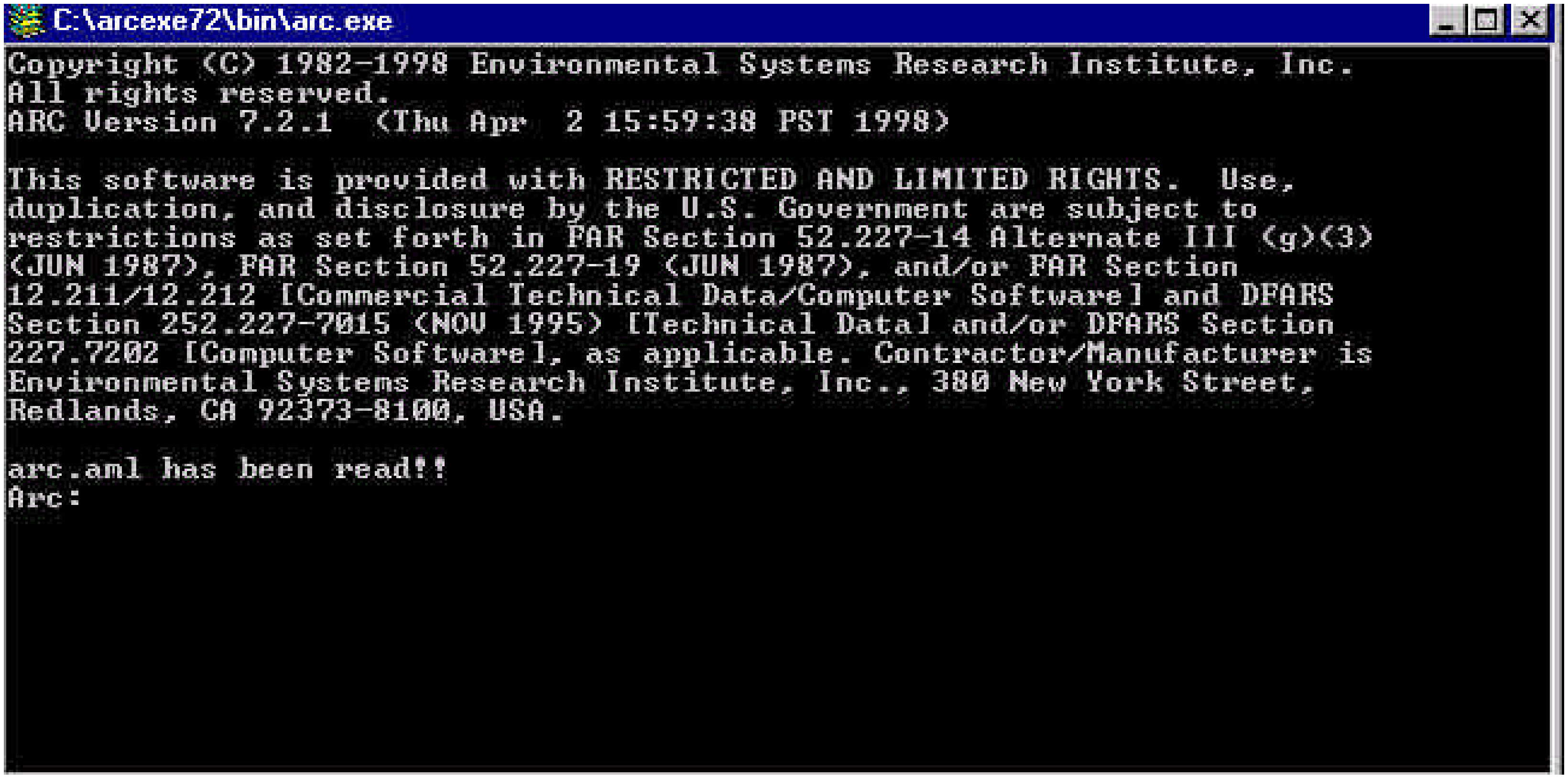
Goal: To provide instruction on adding grids and coverages, and on navigating within the ARCEDIT Environment

3A. Opening ARC/INFO NT

Using Microsoft® Windows® Explorer, navigate to the following directory: **c:\arcexe72\bin**. Here you will find a file labeled **arc.exe**, which is highlighted in the graphic below. Double click on this file to open ARC/INFO.



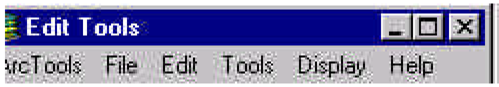
After you have double clicked on the **arc.exe** file, the following window will appear.



Notice at the bottom there is a line which simply reads **Arc:**. This is the **Arc prompt**. From here you will be able to create and access the files containing the data you will be working with as well as run the various ARC/INFO modules (e.g., ARCEDIT, ARCPLOT, etc.). The majority of the commands you will be using will be input from the Arc prompt. However, all of the vectorizing will be performed using components of the ArcTools module explained previously.

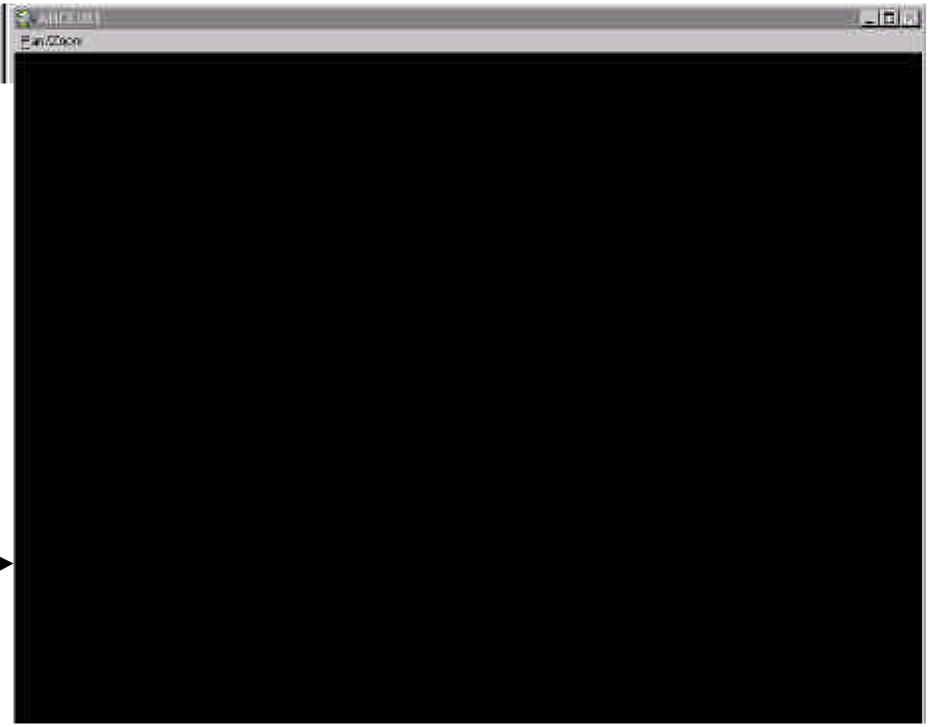
3B. Preparing ArcTools

To access the **ArcTools** user interface, type the following command at the Arc prompt: **&run trace.aml.** This will run the arc macro language (AML) program that opens **ArcTools**. After a few moments, there should be two new windows on your screen: **Edit Tools** and **ARCEDIT**.



Edit Tools Window: Allows the user to add and remove the grids and coverages as well as alter the display formats

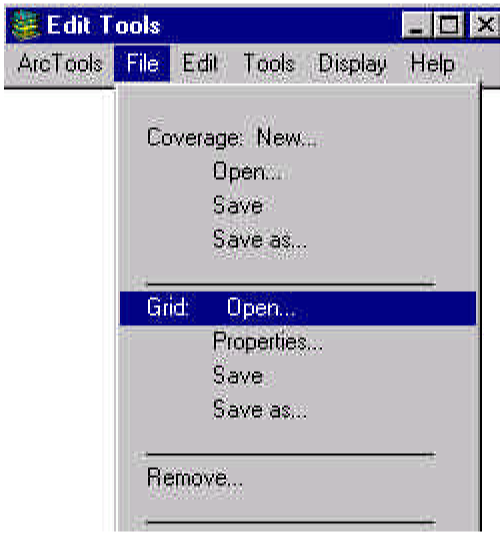
ARCEDIT Window: Displays the coverages and grids used during the vectorization process



By placing the mouse over the top of each window and clicking the **left** button, you can control which window is active. A **blue** title bar indicates a window is **active**, and a **gray** bar indicates a window is **inactive**.   By placing the mouse over an active window, holding down the **left** mouse button, and then moving the mouse, you can adjust the position of any window on the screen. To place it, simply release the mouse button.   Later, you may find a particular arrangement more suited to your needs, but to begin with we recommend placing them as shown above.

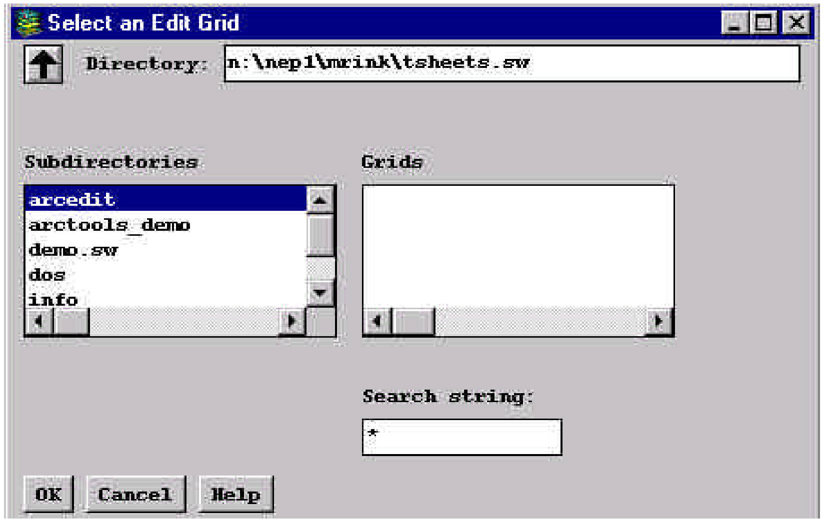
After you have arranged your windows, you are ready to add data to the ARCEDIT window. Each T-Sheet should have its own directory that contains all the data associated with it. A directory containing demonstration data sets has been provided for you. You will use this to learn various vectorization techniques.

I. Adding Grids:

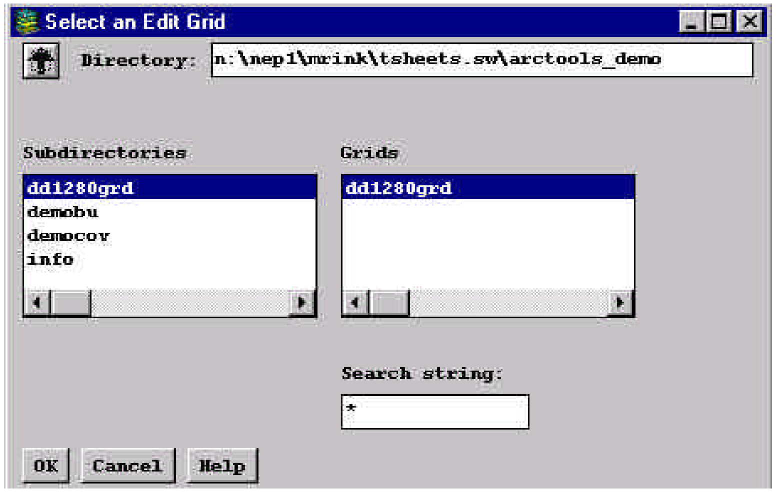


Before beginning to trace any new T-Sheet, you must first add the grid associated with it. To add a T-Sheet's grid, select the **File** option from the **Edit Tools** window. This will activate a drop-down list of choices. Click on **Grid: Open** to add a grid.

You will now see a window titled **Select an Edit Grid**. At this point you can type in the path name to the folder that contains the demo data in the box labeled **Directory** and hit **Return**. Alternatively, you can click on the appropriate subdirectories from the list provided on the left. (Clicking on the large up arrow button will place you back up a level.) Locate **arctools_demo** from the **Subdirectories** list and click once on it.

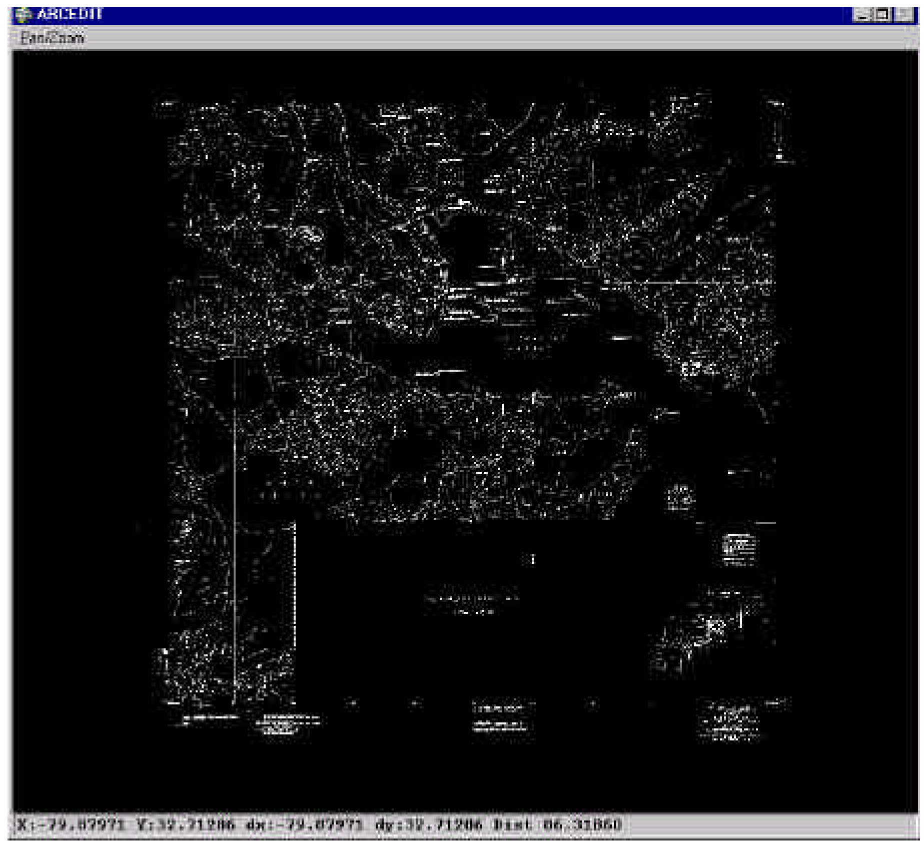


You should now see the contents of the **arctools_demo** directory. To the right of the **Subdirectories** list is another list labeled **Grids**. Appearing under the **Grids** list should be a file called **dd1280grd**. Click on **dd1280grd**. This will add the grid to the **ARCEDIT** display window.

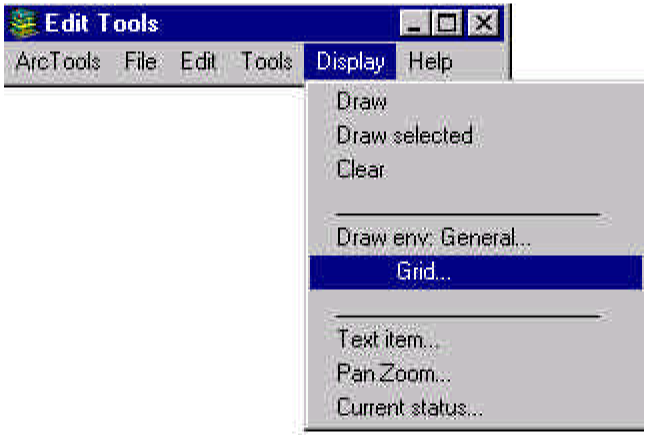


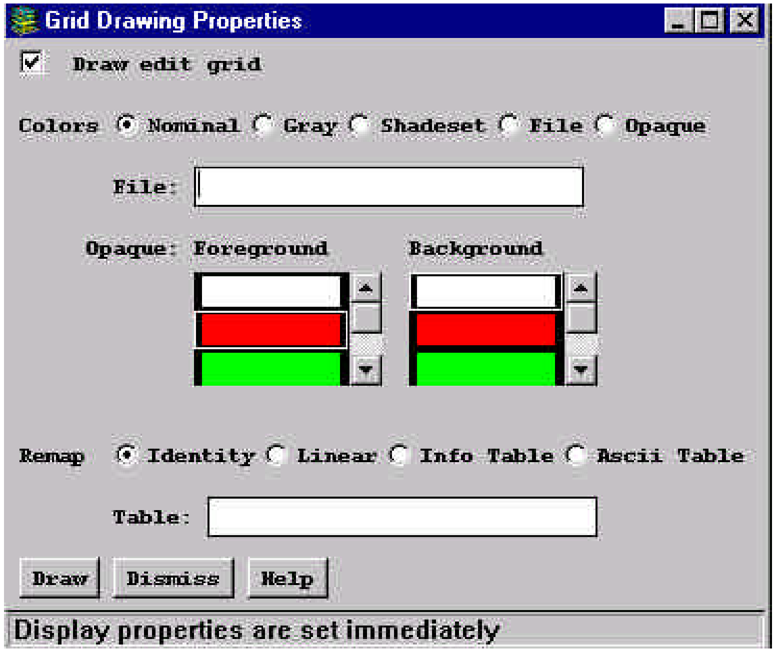
Adding the grid may take a moment or two, so be patient. Soon the grid will display in the ARCEDIT window. Along with it will be a window labeled **Grid Editing**. Click on the **Dismiss** button to remove this window as it will not be used.

Take a moment to inspect the grid. It will typically display as a series of white lines on a black background as seen in the graphic to the right. Since this is often difficult to use, you can alter the color schemes to suit your liking.



From the **Edit Tools** window, click on **Display**. Notice that the drop-down list is split into three sections. From the middle section, just beneath **Draw env: General**, select the **Grid** option. This will open a window called **Grid Drawing Properties** that will allow you to change the appearance of the grid.





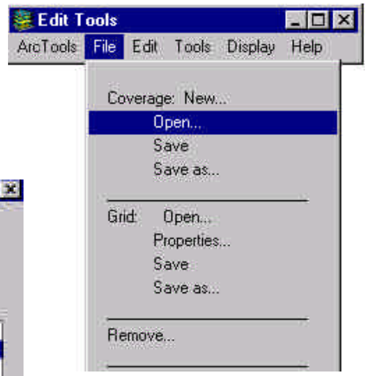
Note: Do not alter any of the default settings for anything else in the Grid Drawing Properties window. Only change the Foreground and Background fields.

Using this window, you can control the colors the grid is displayed with. Use the scroll-down lists labeled **Foreground** and **Background** to set the colors for each. When you have selected colors, click on the **Draw** button to redisplay the grid. If you are not satisfied with a particular color scheme, you can return to the Grid Drawing Properties window and choose a new one. Experiment with different combinations until you find one that you like. (We recommend using a dark color for the foreground, which represents the lines you need to trace. This will make it easier to see the vector lines that will be drawn on top of them. However, avoid using shades of blue for the foreground since it creates confusion when displaying lines that are selected.)

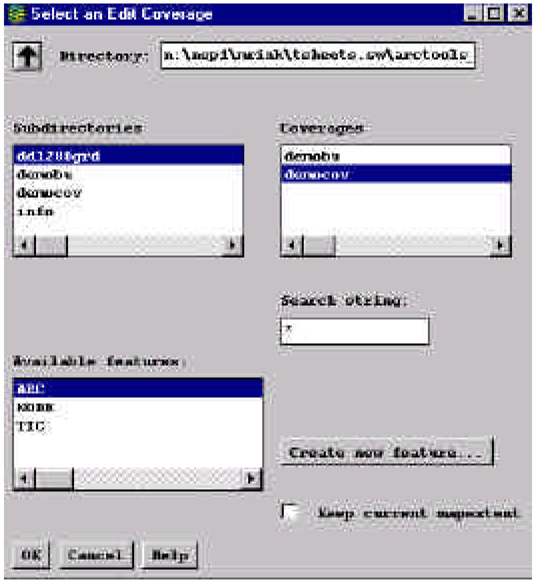
After you have found a suitable color scheme, click **Draw** to apply it, and then **Dismiss** once the grid has redrawn.

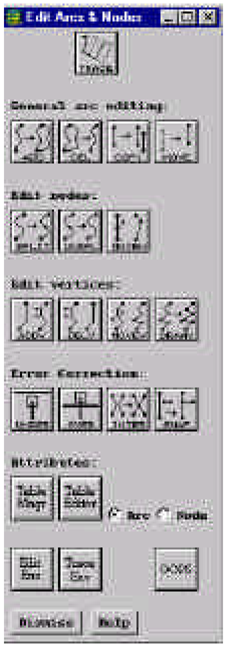
II. Adding Coverages:

From the **Edit Tools** window, click on **File** and select the option **Coverage: Open**. From the **Select an Edit Coverage** window, navigate to the location of the **arctools_demo** directory. Under the list labeled **Coverages**, highlight the one called **democov**. Next, under the list labeled **Available Features**, click the feature type **arc**. Click **OK** when done.



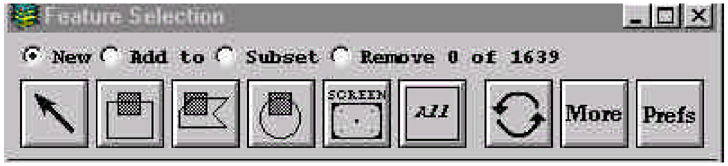
After you click on the **OK** button, three things will happen. First, the ARCEDIT window will redisplay, redrawing the grid. Then it will add the vector coverage. Typically, the coverage will display as white lines, so depending on the color scheme of the grid, this may or may not be easy to see. If not, consider using another grid-color setup. Lastly, once the grid and coverage are drawn, two other windows will appear.





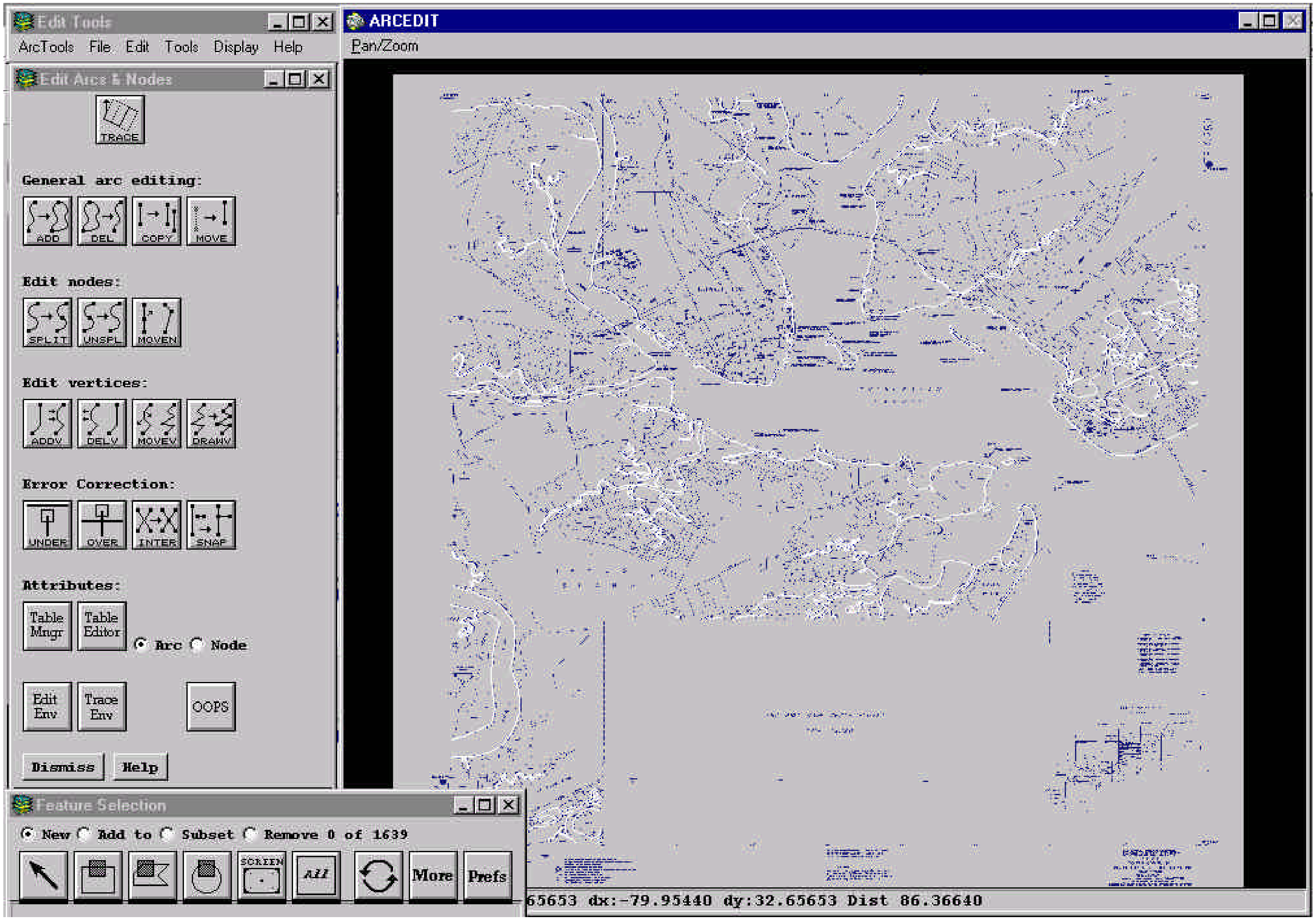
The first window, shown to the left, is labeled **Edit Arcs & Nodes**. It contains a list of icons to vectorize (trace), edit, and add attribute data to the lines you will be creating

The second window, seen to the right, is called **Feature Selection**. This contains tools that will provide a variety of options for selecting lines to edit.

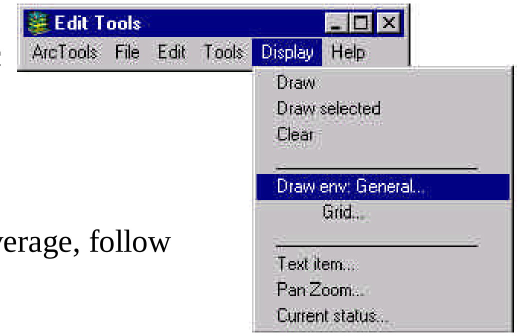


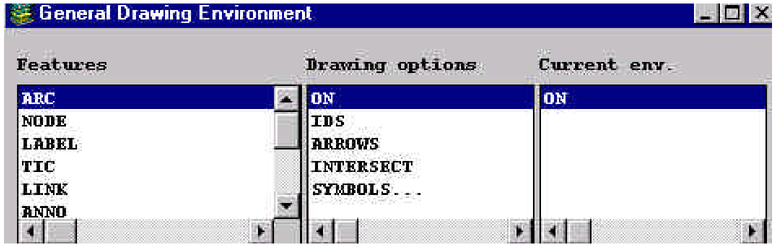
At this point, four windows should now be open on your screen: **Edit Tools**, **Edit Arcs & Nodes**, **Feature Selection,** and the **ARCEDIT** display.. To provide the greatest ease of use, arrange them as shown on the following page.

Configure your screen to look similar to the graphic below. You may need to resize the windows by placing your cursor on an edge and dragging it while holding down the left mouse button.



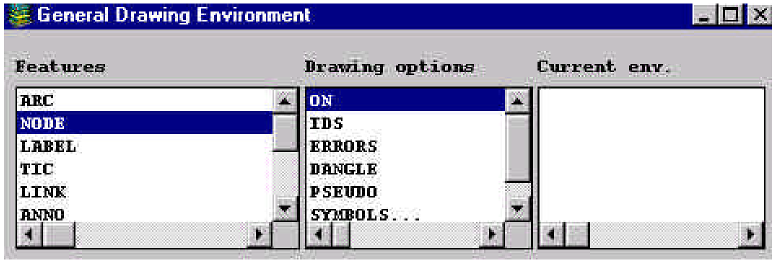
After your windows are arranged, click on the **Display** option on the **Edit Tools** window. From the list of choices, select **Draw env: General** as illustrated in the graphic to the right. This will open a window labeled **General Drawing Environment**, shown below. This will allow you to alter the look of the coverage much in the same way **Grid Drawing Properties** allowed you to change the appearance of the grid.



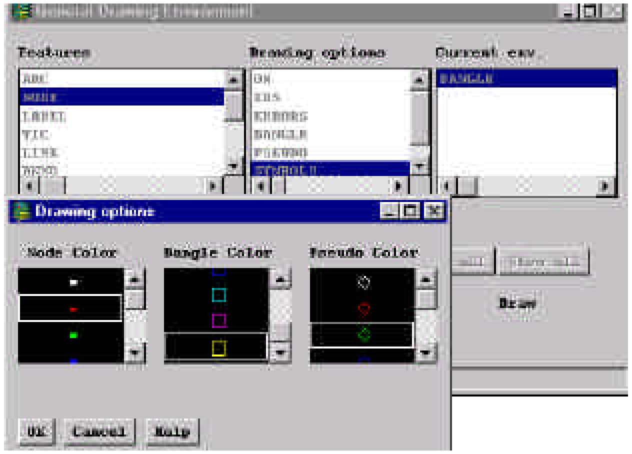


To alter the look of the coverage, follow these steps:

First, under the list labeled **Features**, click on the **Node** option. This will add several other options to the **Drawing options** list.



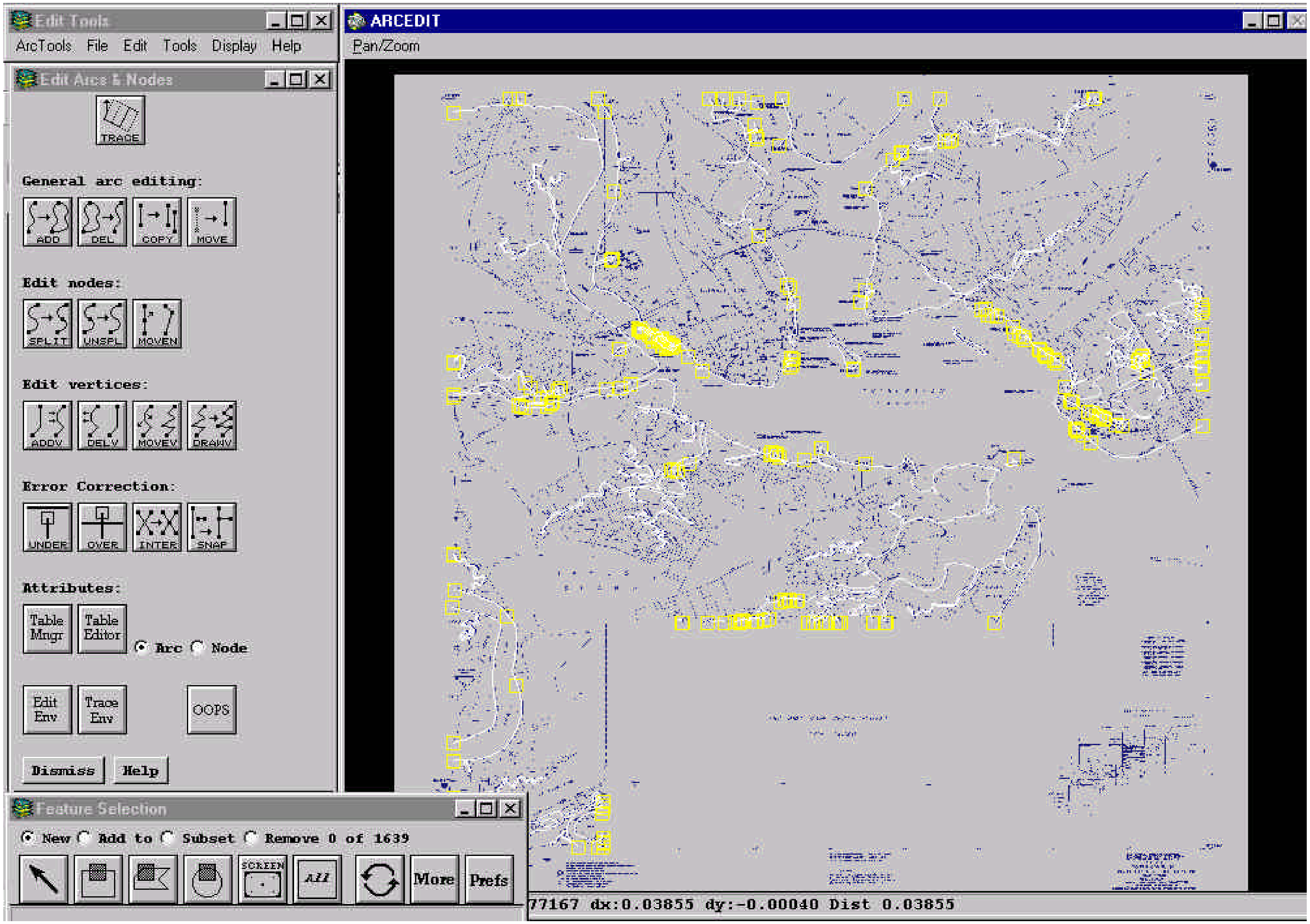
Second, from the new additions under the **Drawing options** list, first click on **Dangle**, then on **Symbols**.



Finally, from the window labeled **Drawing options**, select colors for the **Nodes**, **Dangles**, and **Pseudo Nodes**. (These are all elements of the lines you will be creating, and are explained later.) Your choices will depend largely on the colors chosen for the grid, and can be altered by following the above steps and selecting new colors if necessary.

Once the colors are set, click **OK** in the **Drawing options** window. Then click the **Apply** button in the **General Drawing Environment** window to add your choices to the **ARCEDIT** window. This may take a few seconds. When your additions have been displayed, remove the **General Drawing Environment** window by clicking the **Dismiss** button.

Your **ARCEDIT** window should now look similar to the graphic below. Notice all of the dangles, which appear as squares.



III. Moving Around in the ARCEDIT Window:

Make the **ARCEDIT** window active by clicking with the mouse button on its title bar. Recall that active windows have blue title bars. Once it's active, click on the button labeled**Pan/Zoom**. This will provide a drop-down list of options that will allow you to navigate through the **ARCEDIT** window. These tools can be accessed either by clicking on them through this window, or by using the keyboard shortcuts listed beside each option.

- **Pan**: allows the user to move the grid around in the window by holding down the left mouse button and dragging the cursor
- **Zoom In**: allows the user to zoom in on any location in the window by providing a special cursor. The user will have to place the cursor on a location and click to activate the zoom
- **Zoom Out**: the reverse of the **Zoom In** option
- **Zoom In Center**: allows the user to zoom to the center of the **ARCEDIT** window. This does not require the user to use the cursor
- **Zoom Out Center**: the reverse of **Zoom In Center**
- **Extent**: allows the user to section off a particular area of the window to zoom in on. The user will have to use the cursor to define a box containing the area of interest
- **Fullview**: allows the user to return to the full extent of the map area. This is a good way to quickly "back out" of any mistakes
- **Redisplay**: allows the user to remove any unwanted lines that may appear during the course of editing. These lines are referred to as "Graphic garbage"

Create, **Get Extent**, and **Scale 1:1** are not options that are readily useful to the vectorization process.

Take a few moments to familiarize yourself with these functions by using them to pan and zoom in and out on the various features of the map. If you get stuck, remember that the **Fullview** option will redisplay the map to its original, complete extent. After you are reasonably comfortable, you are ready to begin vectorizing.

END

Chapter 4. Demo: ArcScan Procedures

4A. Vectorizing the Shoreline

Goal: To provide instruction on how to use the Trace function

4B. Techniques for Editing the Coverage

Goal: To provide instruction on how to address dangles, select arcs, move vertices, and edit arcs

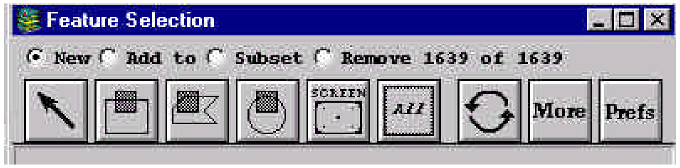
4C. Editing Summary

Goal: To recap several common editing tools and procedures

4D. An Exercise

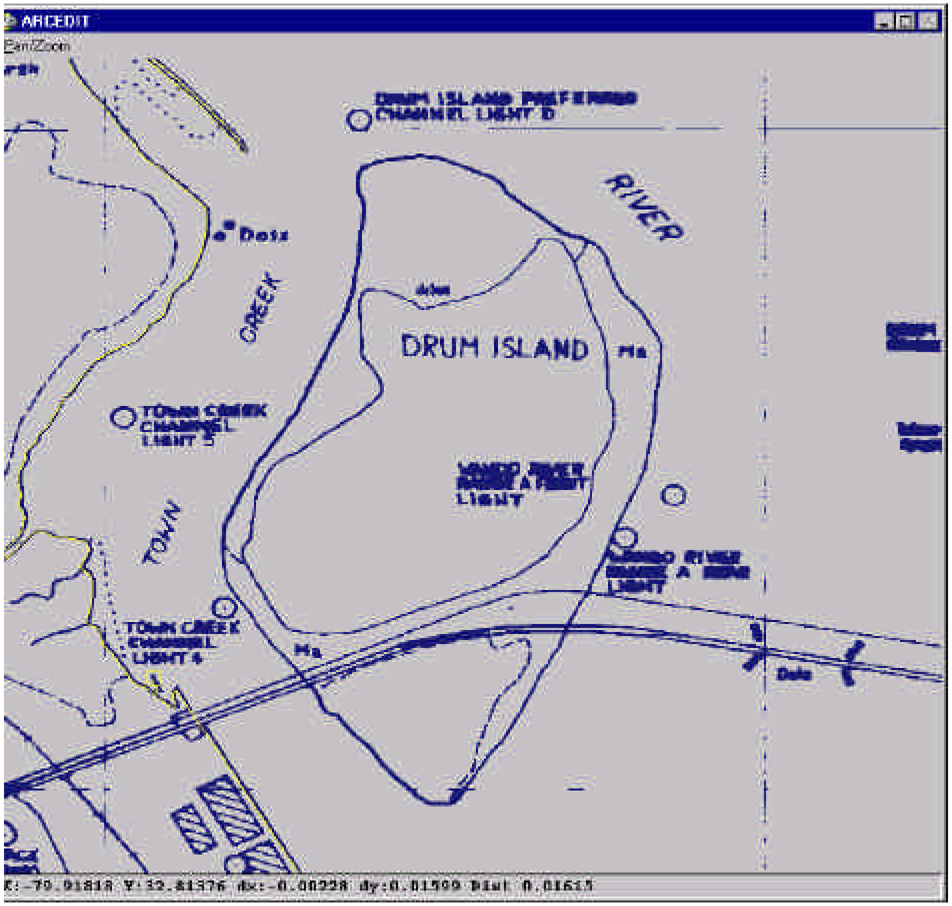
Goal: To practice vectorizing shoreline data

4A. Vectorizing the Shoreline



Reset the size of the map to its **Fullview**. Once the entire map is shown, click on the button labeled **All** from the **Feature Selection** window.

You should notice that this has selected all of the lines in the coverage. (Lines that are yellow indicate they are selected.) You may also see that there is an island just to the east of the Charleston peninsula that has not been traced. This is Drum Island, your first job. It is located in the middle of the map, about one-fifth of the way down. To begin, you will need to zoom into it.



Make the **ARCEDIT** window active, and click on the **Pan/Zoom** option. Select **Extent** from the drop-down list. To use the **Extent** tool, you will be drawing a box that defines the extent of what you want to focus on.

When you have located Drum Island, use the cursor (which should look like a crosshair) to **left click** once in the **upper left corner** of the island.

Drag the cursor to the **lower right corner** of the island to define the rest of the box. When you have the whole island inside the extent, **left click** the cursor again to finish.

The **ARCEDIT** window will redisplay to focus on just the island.

Try to make your window look similar to the one shown at the right.

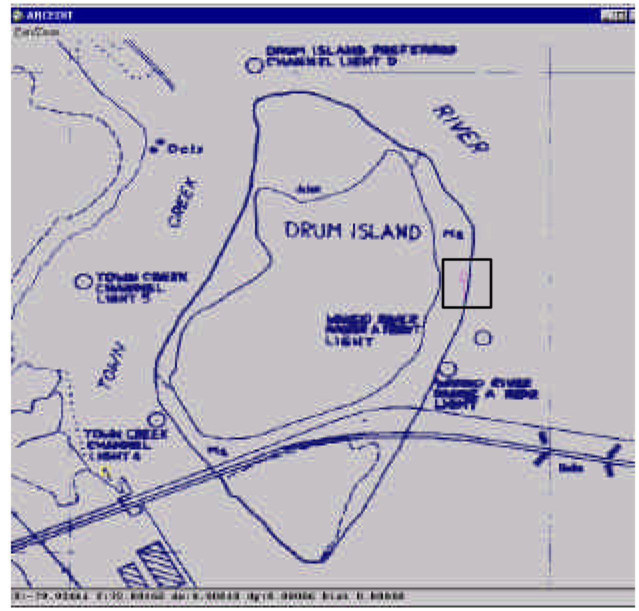
I. Using the Trace Function:

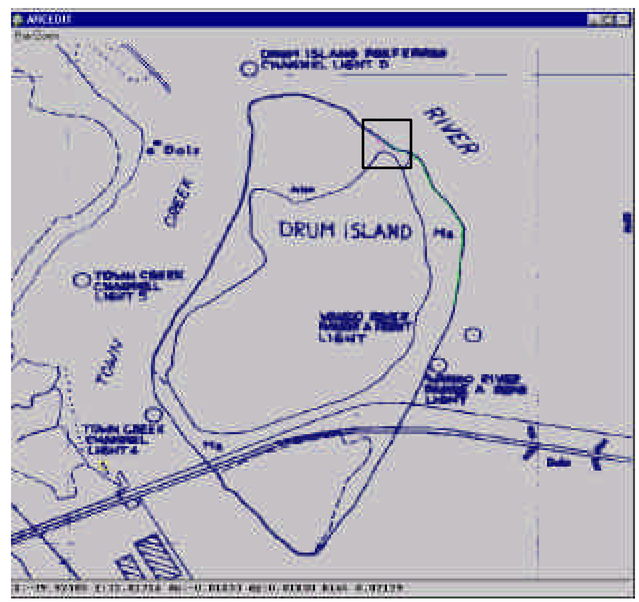
Once Drum Island is in view, you can begin to trace it. Make the window labeled **Edit Arcs & Nodes** active; then click on the button at the very top labeled **Trace**. When you move the cursor into the **ARCEDIT** window, another crosshair will appear. Position the crosshair on part of the shoreline of the island. (Try to keep it away from where the bridge crosses over.) When it is in place, **left click** the mouse. An arrow should appear as highlighted by the box in the graphic to the right.

The tracing program will now give you the ability to determine the direction you want to proceed in vectorizing the line. You can change the direction of the trace by pressing **2** on the keyboard. Try this and observe the arrow.

Once the direction is set, **right click** with the mouse to begin the trace, or press the number **3** on the keyboard. Note that the tracer stops when it comes to a point where another line intersects the line you are tracing, as illustrated in the box to the right. These are called **junctions**, and at each junction the user must control the tracer direction by using one of the methods mentioned above. When you have properly set the direction, **right click** with the mouse again to resume the trace.

Note: Depending on the lines involved, the tracer may not always stop. If it continues down the wrong line, you will have to correct it (see the next page for how).





Continue on and trace the entire island. If you get stuck or find that the tracer has collected the wrong line at any time, don't worry. Here is a list of available options that you will find useful. Simply type the keyboard number of each to use it. When you have the entire island done, press **9** on the keyboard to end the trace. If you have any questions during the process, don't hesitate to ask an instructor.

Useful Options for the Trace Function:

1 - Switch to manual digitizing (you can use this if you encounter an area where there are many lines intersecting the one you are trying to trace, or if you prefer more control of where to place the line)

2 - Change tracing direction

3 - Trace along the indicated direction

4 - Select a new junction

5 - Move back a junction

6 - Move forward a junction

7 - Delete all arcs after the current junction

8 - Auto-trace mode **(<u>Do not use this</u>. It automatically begins to trace EVERY line on the map)**

9 - Stop tracing

Note: When performing an edit, especially deleting, there may be "graphic garbage" that appears on the screen. It is a good idea to redisplay the screen (Ctrl-R) after each edit to clean it.

When you have finished tracing the island, you may notice several colored squares that appear along the traced lines. These are the **dangles** mentioned earlier, and are important features of the vectorization process that need to be addressed. Lines and polygons are made up of a series of connected points. Some of these points have special names:

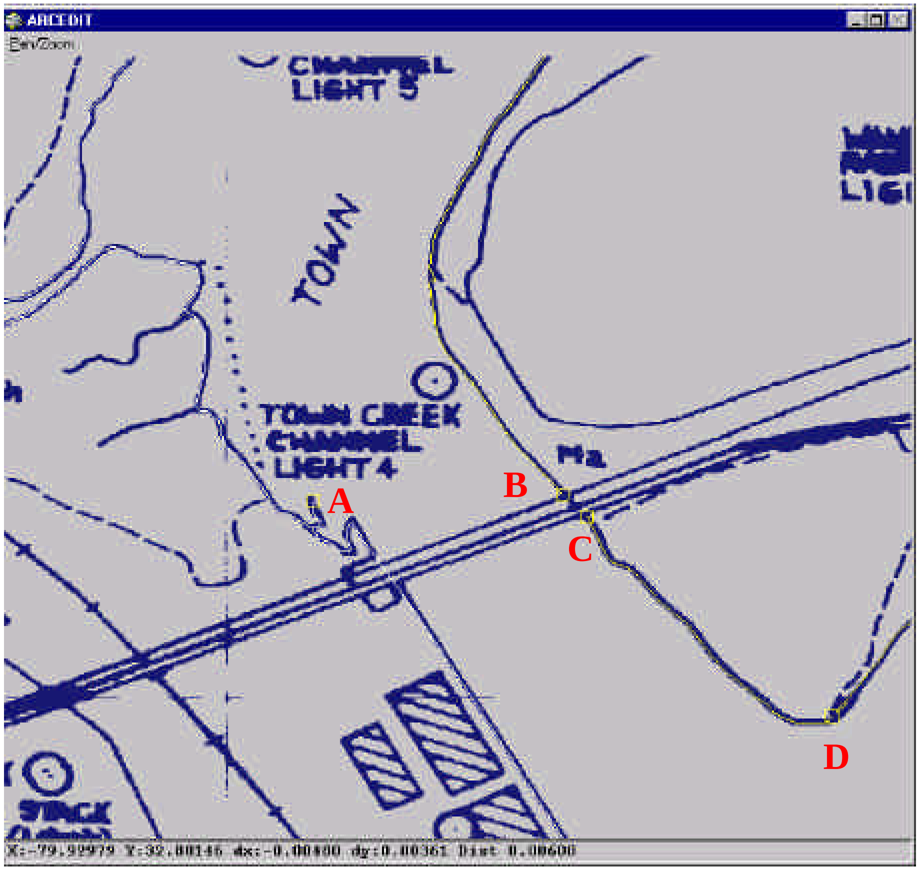
- **Nodes**: indicate the two end points of an arc
- **Dangles**: indicate an unconnected beginning or end of an arc
- **Pseudo-nodes**: indicate two or more arcs have been connected together

When you first add a coverage, these features are not automatically turned on. In order to see these, it is necessary to edit the coverage with the **General Drawing Environment**. Remember to perform this step any time you add a new coverage. This way you will be able to see them as you trace along.

4B. Techniques for Editing the Coverage

I. Dangles:

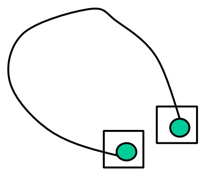
If you look in the lower left corner of the screen with Drum Island, you should see several dangles. A zoomed-in graphic of the area in question is shown at the right. A dangle indicates that the arc you traced has been left hanging. Depending on the situation, dangles can be either good or bad.



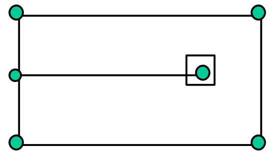
One situation, labeled with an A in the graphic to the right, represents a pier or jetty. This is an acceptable dangle. A pier is essentially a line that extends out into the water and just ends.

The other situations, labeled B, C, and D, occur on the island where the shoreline intersects with some of the other lines on the map. These dangles are unacceptable because they prevent the complete enclosure of the polygon. Recall that a polygon, such as an island, must begin and end with the same point, and therefore is "closed." In this scenario, there isn't a polygon, but rather several individual lines. These are types of dangles that will need to be corrected.

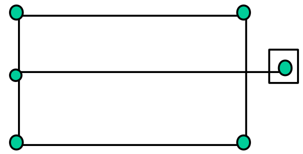
The next page illustrates several other types of dangles and graphical features you will encounter.



An Open Polygon

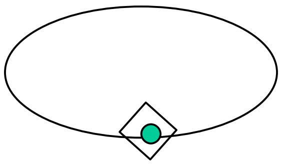


An “Undershoot”

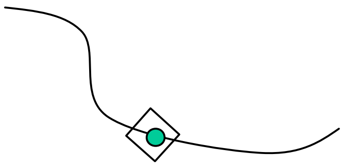


An “Overshoot”

The graphics above show three types of dangles. The **open polygon** and the **undershoot** are the two worst kinds to have. In each case, they fail to completely close a polygon or polygons. These are dangles that will need to be edited. Many **overshoots**, while creating closed polygons, will also need to be dealt with. (Bear in mind that some overshoots, such as piers or jetties represent acceptable types of overshoots. These can be left alone.)



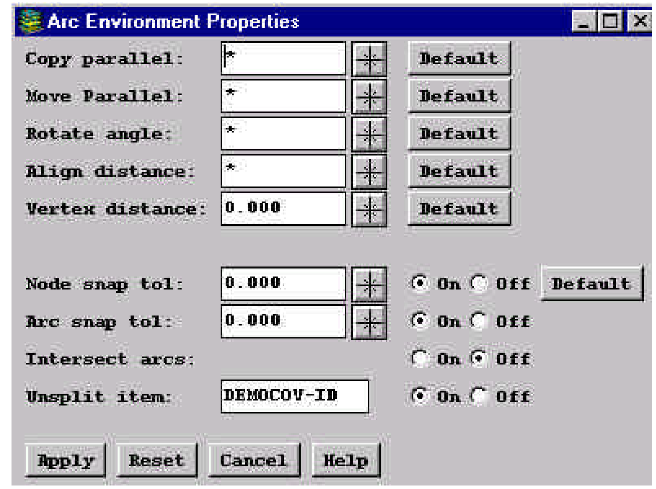
An Island Pseudo Node



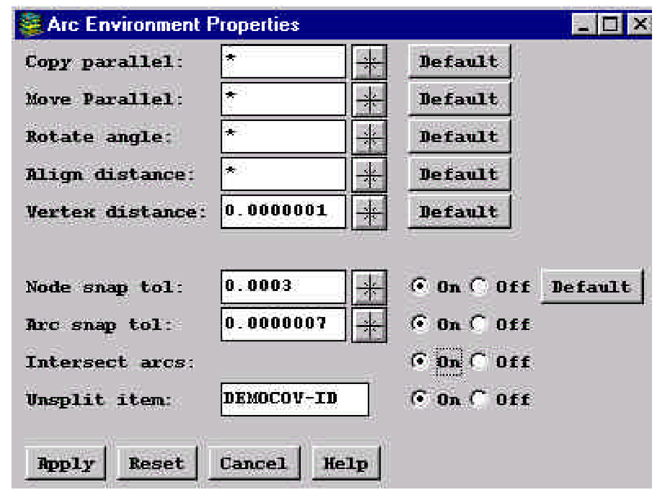
Pseudo Node Marking the Intersection of Two Arcs

The two graphics above illustrate a **pseudo**, or false, node. This is a graphical feature that displays the connection of two separate arcs. A pseudo node is displayed with a diamond instead of a square. This feature tells the user that **ArcScan** has simply joined two or more lines together. There is no editing that needs to be performed on a pseudo node.

The more dangles that are created, the longer it will take to correct them. Fortunately, it is possible to prevent many of them from occurring in the first place. The key is to set up some tracing tolerances for your vectorized arcs to follow. To set these tolerances, make the **Edit Arcs & Nodes** window active and then click on the button labeled **Edit Env**. This will open a window labeled **Arc Environment Properties**. You will want to focus on the four criteria of **Vertex distance, Node snap tolerance, Arc snap tolerance,** and **Intersect Arcs**. To set these, use your mouse to click inside the input box, delete the current value, type in the new value, and hit **Return**. Enter the values as follows:



- **Vertex Distance**: controls the distances between vertices. **Set this value to 0.0000001 and hit Return**.
- **Node Snap Tolerance**: connects the node of one arc with a node of another if it falls within the defined tolerance. This will be most important when doing manual digitizing, which will be explained later. **Set this value to 0.0003 and hit Return.**
- **Arc Snap Tolerance**: connects the node of a traced arc onto an existing arc, whether it contains a node or not. This will essentially create a node on the existing arc at the junction. **Set this value to 0.0000007 and hit Return**.
- **Intersect Arcs**: allows arcs to intersect. This makes overshoot dangles easy to fix. **Use your mouse to turn this On.**

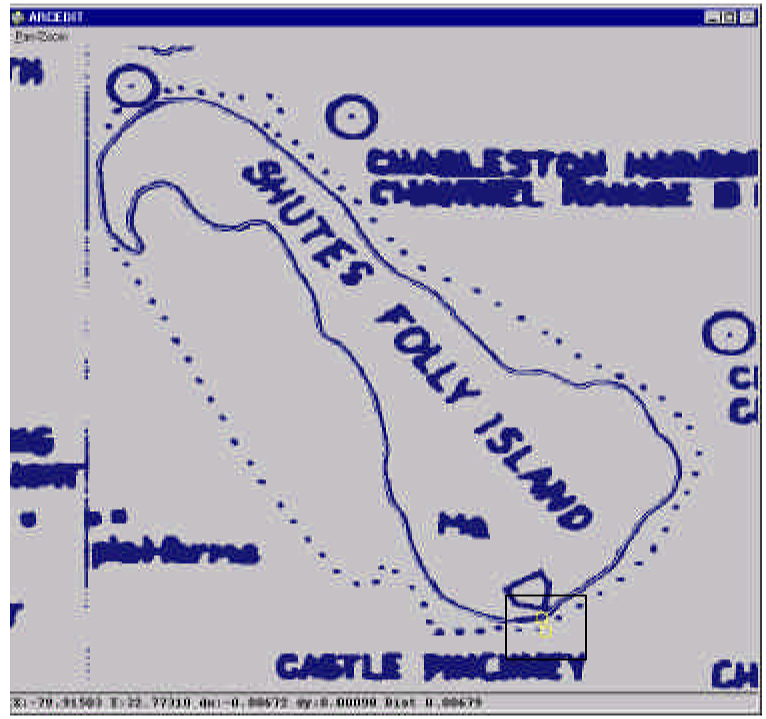


When your window looks like the one shown to the right, click **Apply** to set your values, then **Cancel** to dismiss the window.

ArcTools will not redisplay more than three decimal places after the **Arc Environment Properties** window is closed. This means once the changes are applied and the window is closed, if you were to reopen the window, you would not see the values you typed. As long as you hit **Enter** after each input and clicked **Apply** before closing the window, everything will be fine.

II. Selecting Arcs:

After you have set the tolerance values, make the **ARCEDIT** window active and use the **Pan/Zoom** options to display a **Fullview** of the map. Then use the **Extent** tool to locate and zoom into Shutes Folly Island, southeast of Drum Island and near the tip of Charleston peninsula. Follow the same procedure as when zooming into Drum Island, and try to make your display look similar to the graphic to the right.

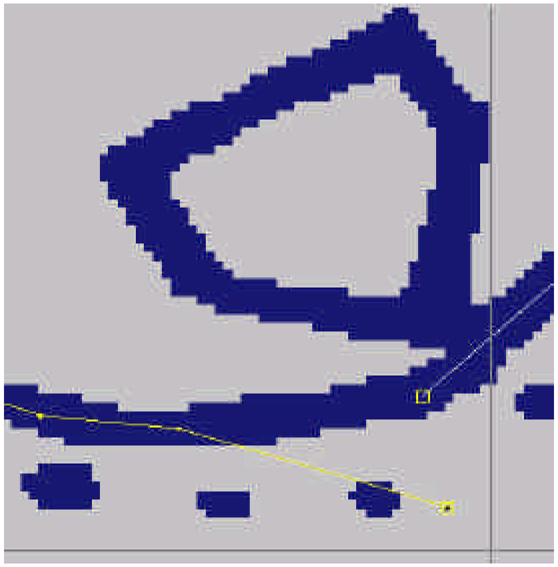


Notice that there are two dangles on the southern end of the island. Use the **Extent** tool to zoom in closer to these. In the graphic to the lower right, notice that one dangle is resting on the raster line, and one is not. (Also observe the width of the raster line, as well as the stair-step effect alluded to in Chapter 1.) To correct this problem we will move the dangle that is off the line and connect it to the one on the line.

Make the **Feature Selection** window active and click on the **arrow** button. This button will allow you to select an arc you have traced. When you move your cursor back into the **ARCEDIT** window, it appears as a crosshair with a circle around the center. The arc must fall within this circle in order to be selected.

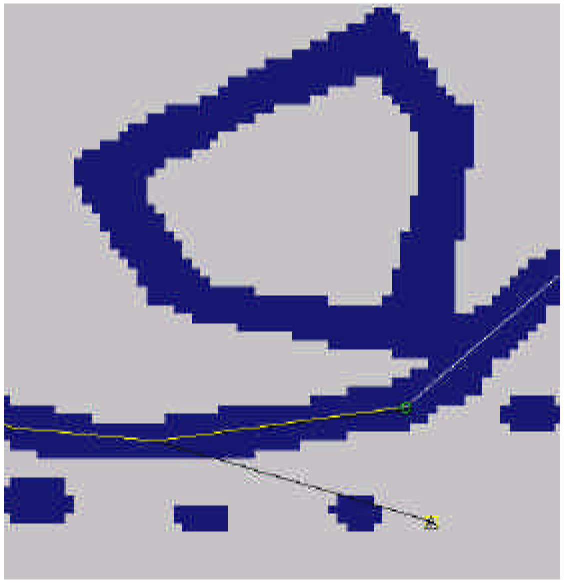
Position the center of the crosshairs over the arc that is off the raster line and **left click** with the mouse. The arc will turn yellow, indicating that it is selected. Type **9** on the keyboard to end the selection process.

III. Moving Vertices:



After the arc is selected, it needs to be moved. Make the **Edit Arcs & Nodes** window active. Under the **Edit Vertices** heading, click on the button labeled **movev.** This allows you to move a vertex on a selected arc. After you have clicked on the **movev** button, use the cursor to point to the dangle and **left click** on it. A triangle will appear on top of the dangling node meaning that it is selected.

Next, press the number **4** on the keyboard. This indicates you wish to move the selected vertex. Then place the cursor on top of the dangle that lies on the raster line and **left click** to move the vertex. Press the number **9** on the keyboard to end the move.

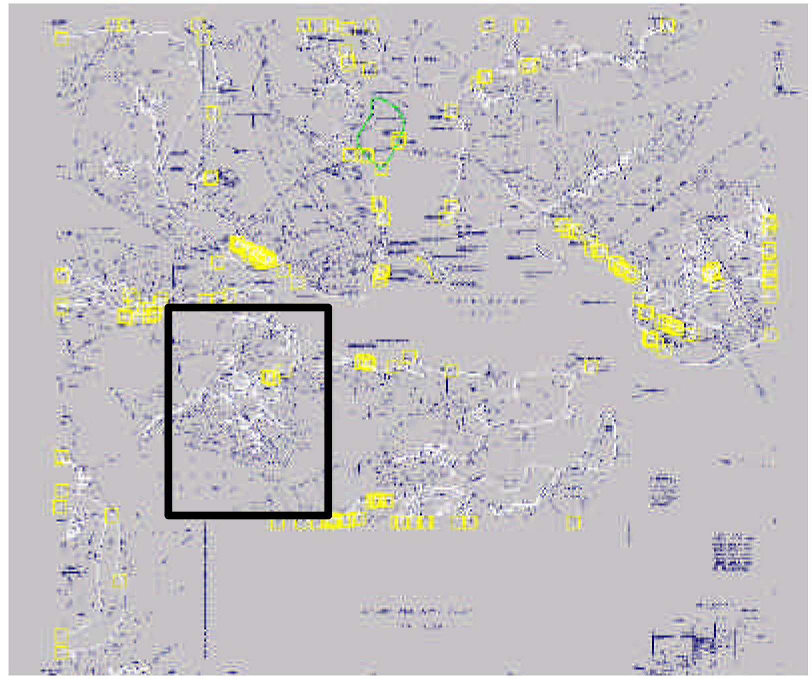


If everything was performed correctly, your window should look like the one at the lower right. Notice that the two arcs are joined together at a pseudo node, indicated by a diamond shape. However, the original arc and dangle appear to be still present. This is an example of the "graphic garbage" mentioned earlier. Use the **Redisplay** option from the **Pan/Zoom** drop-down menu to remove this.

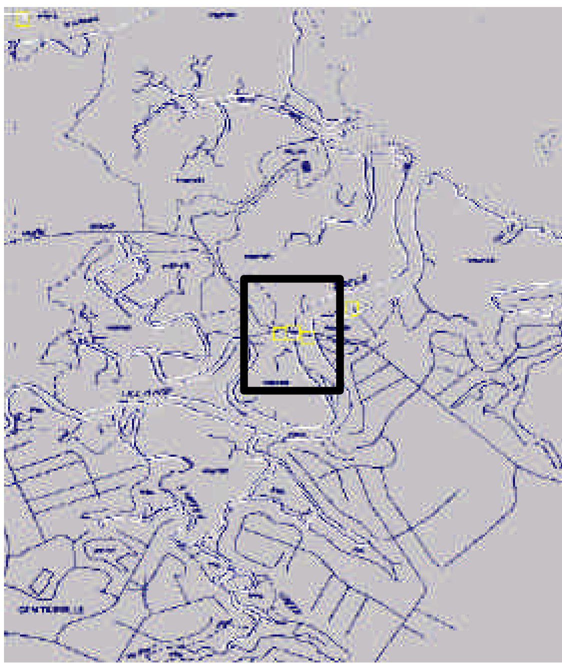
If it is difficult to see the nodes, pseudo nodes, and dangles, consult Chapter 3B for instructions on how to change the coverage's drawing environment.

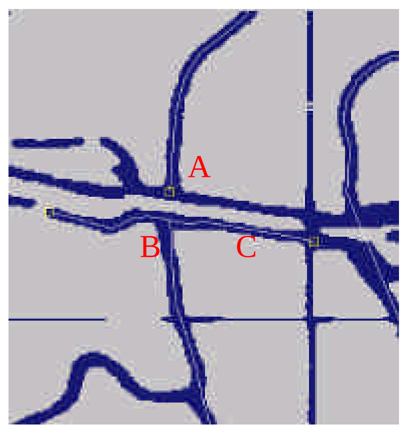
IV. Editing Arcs:

Make the **ARCEDIT** window active and use the **Fullview** option to display the entire map. Then use the **Extent** tool to zoom into the area indicated by the rectangle in the graphic to the right.



The graphic below should give an approximation of the zoomed-in area. Use the **Extent** tool to zoom in further, using the rectangle below as a guide.





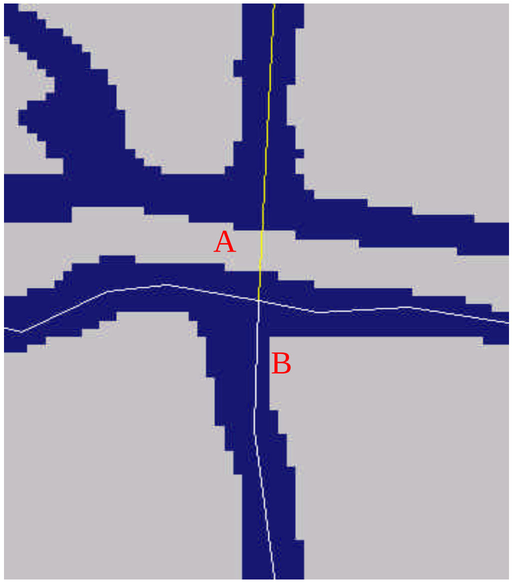
There are three corrections that must be made in this example:

- an arc (A) that has stopped short of a bridge and needs to be extended.
- a piece of linework (B) on the opposite side of the bridge from (A) needs to be properly centered.
- part of the bridge (C) has been vectorized and needs to be deleted.

To extend the arc labeled (A):

Make the **Feature Selection** window active, click on the **arrow** button, then click on the arc that needs to be extended. When it turns yellow, it has been selected. Type **9** to end the selection.

Make the **Edit Arcs & Nodes** window active, and under the **Edit Vertices** heading, click on the **movev** icon to move a vertex. Select the end vertex then hit **4** on the keyboard to indicate that you want to move it. Next move the crosshairs to the opposite shoreline (B) and **left click** the mouse where the other line begins. Hit **9** to end the move, and then **Redisplay** it to remove any graphic garbage. The result should look like the picture to the right.

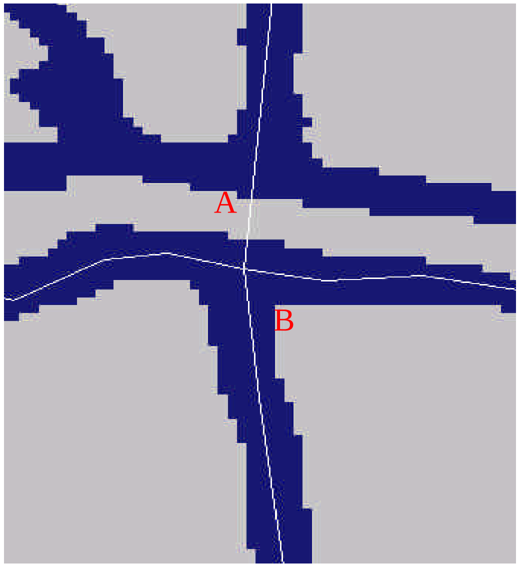


Notice that (A) has snapped to the end of (B) on the opposite shoreline. However, (B) does not fall in the center of the raster line, it strays to the right. We want to be sure that any vector lines stay in the center of the raster lines as much as possible.

To align the arc labeled (B):

Since in the previous step we joined two arcs, a node was created at the junction. Make the **Edit Arcs & Nodes** window active and under the **Edit nodes** heading click on the **moven** button. This will move nodes. Position the crosshairs over the junction point and **left click**. The node should now appear.

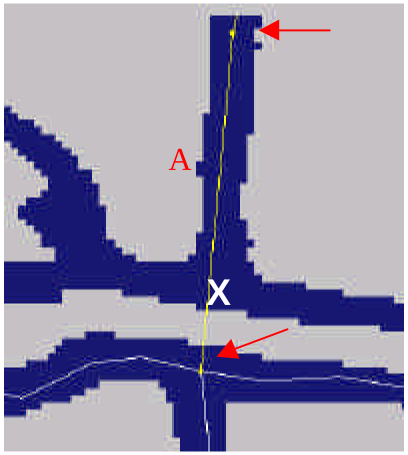
After it appears, hit **4** on the keyboard to indicate you want to move the node. Next, move the cursor to a position slightly to the left, so arc (B) will be better aligned with the middle of the raster line. **Left click** with the mouse to move the node, type **9** to end the move process, and **Redisplay** the screen. The result should look like the graphic to the right.



This process serves to illustrate an important concept. Sometimes, correcting one problem may create another. Notice that while we have corrected the problem with arc (B), it has moved arc (A) out of alignment. Be sure always to check your work while editing. Correcting this particular problem is very simple though.

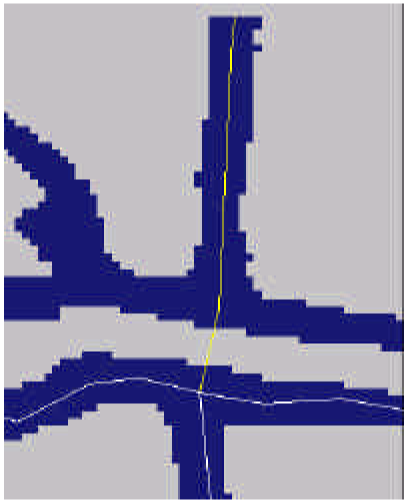
To readjust arc (A):

Make the **Feature Selection** window active and use the arrow to select arc (A). When it has been highlighted, press **9** to end the selection, make the **Edit Arcs & Nodes** window active, and click on the button labeled **drawv**. You should see at least two vertices, as illustrated with arrows to the right. If not, readjust your window with the **Zoom/Pan** tools so they come into view.



What you will need to do is add a vertex between these to bend the arc (A) back towards the right.

Once the vertices are in view, click on the button labeled **addv** from the **Edit Arcs & Nodes** window. With the crosshairs, place the cursor in the area indicated by the "X" so the arc will run down the middle of the raster line as close as possible, and **left click** to add the vertex. Press **9** to end the add process, and **Redisplay** your screen. The result should look like the graphic at the bottom right. Did you see how arc (A) bent to accommodate the new vertex you added?



Using the process above to add vertices to existing arcs is very useful for two reasons. First, it can easily move an arc to line up better with the middle of a raster line. Second, by adding more vertices, you can "smooth" out a vector line whose appearance looks too choppy. (This occurs many times when tracing around curves.)

Note: A lot of time can be spent on processes such as smoothing and adjusting. It's important not to go overboard with a lot of extra editing.

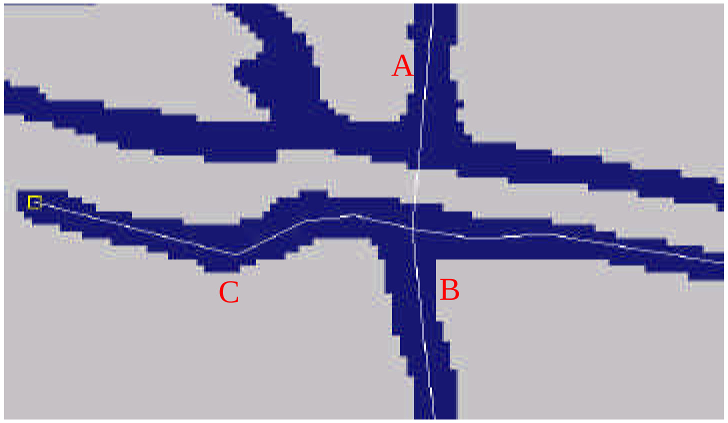
The last task is to remove the arcs that represent the bridge. This is one of the easiest of all the editing processes.

To delete arc (C):

Use the selection arrow found in the **Feature Selection** window. Select on the arc and type **9** to end the selection.

From the **Edit Arcs & Nodes**, under the **General Arc Editing** heading, click the button marked **del**. The arc you highlighted should now be deleted as seen in the picture below. **Redisplay** your screen using **Ctrl+r** or the **Pan/Zoom** drop down list.

Note: This process is also a good way to remove the overshoot type of dangle.



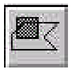
As you are working, you may accidentally perform an edit that you did not want, or the result may not be to your liking. In such an event, you can use the **OOPS** button found on the **Edit Arcs & Nodes** window. This will undo the previous edit. You can even undo multiple steps, up to the last time you saved. Click once on the **OOPS** button to undo the arc you deleted, then delete the bridge again. After you have used the **OOPS** button go ahead and delete the arc that appears on the other side of arc (B).

This section illustrates some of the more common ways to solve several editing problems. However, like any problem, there are often many ways to solve it. As you vectorize your coverages, there will be times when you may need to try several options before a problem is properly resolved. As you become more proficient, it will become easier to see which options might work and which might not. (The **OOPS** button becomes very useful in these scenarios.)

4C. Editing Summary

From the **Feature Selection** window:


Selects an arc or arcs individually. Click this button, and **left click** on the arc. Type **9** to end the selection and move on to the next step.


Selects all arcs intersecting a polygon defined by the user. Click this button, then **left click** once on the screen. Continue **left clicking** to place the vertices of the polygon. Press **9** to end the polygon.

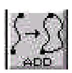

Selects all of the lines in a coverage.


Inverts the selection. What is currently selected becomes unselected, and what was unselected becomes selected.

At the top of the **Feature Selection** window, there are a series of buttons. For the majority of the time you are selecting, make sure the button marked **New** is checked. If you want to turn off a selected arc or arcs, change this setting to **Remove**. You will need to ensure this is reset to **New** in order to begin selecting again.

From the **Edit Arcs & Nodes** window:

Tracing Lines: Click on the **trace** button. Place the cursor where you want to begin and **left click**. Press **2** to change the direction of the cursor. Press **3** to begin the trace. Press **5** to move back a junction. Press **9** to end the trace.

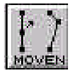


Adding Lines: When it is not convenient to use the trace option, you can manually add arcs with the **add** button. **Press 2** to begin a line. Use the **left button** to add vertices. **Press 2 again** to end the line. Press **9** to end the process.

Deleting Lines: Select an arc or arcs. Press the **delete** button to remove them.

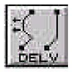
Splitting Lines: Allows you to split one arc into multiple arcs. Useful to delete a part of a line rather than the whole thing. Select an arc, click the **split** button, and use the mouse to **left click** where you want to add the split. Press **9** when done.

Unsplitting Lines: Removes a split in an arc. Select the arcs on either side of the split and click the **unsplit** button.



Moving Nodes: Click the **moven** button. When the node is highlighted, press **4** to begin the move. Use the cursor and **left click** when you want to place the node. Press **9** to end the move.

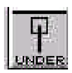
Adding Vertices: Select the arc. Click the **addv** button. Use the cursor and **left click** to add vertices along where you want the arc to fall. Press **9** to end the add process.



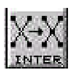
Deleting Vertices: Select the line. Press the **delv** button. Use the cursor and **left click** to select the vertex to delete. Press **4** to delete the vertex. Press **9** to end the process.

Moving Vertices: Similar to moving nodes. First select the arc; then simply use the **movev** button instead.

Drawing Vertices: Select the arc. Click on the **drawv** button to display all the vertices on the arc.



Correcting an Undershoot: Select both the arcs. Click on the **under** button. With the cursor, place the crosshairs over the end of the arc that needs to be moved. **Left click** the mouse. A line will appear. Move the crosshair to place the line on the arc that you want to move the undershoot to. **Left click** the mouse again. The undershot arc should connect to the other arc. **Redisplay** the screen.



Creating an Intersection: Places a junction point common to several lines. Select the arcs and click the **inter** button. Press **9** to end the process.

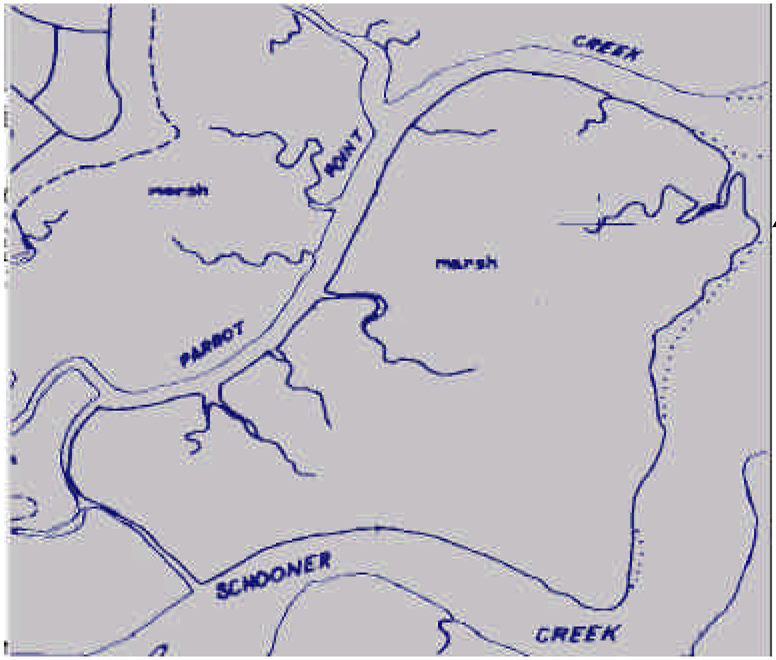
OOPS: Undoes previous edit(s). Each time the button is pressed, it undoes a previous step up to the last time the coverage was saved. Since this can potentially undo a great deal of work, remember to save your coverage often.

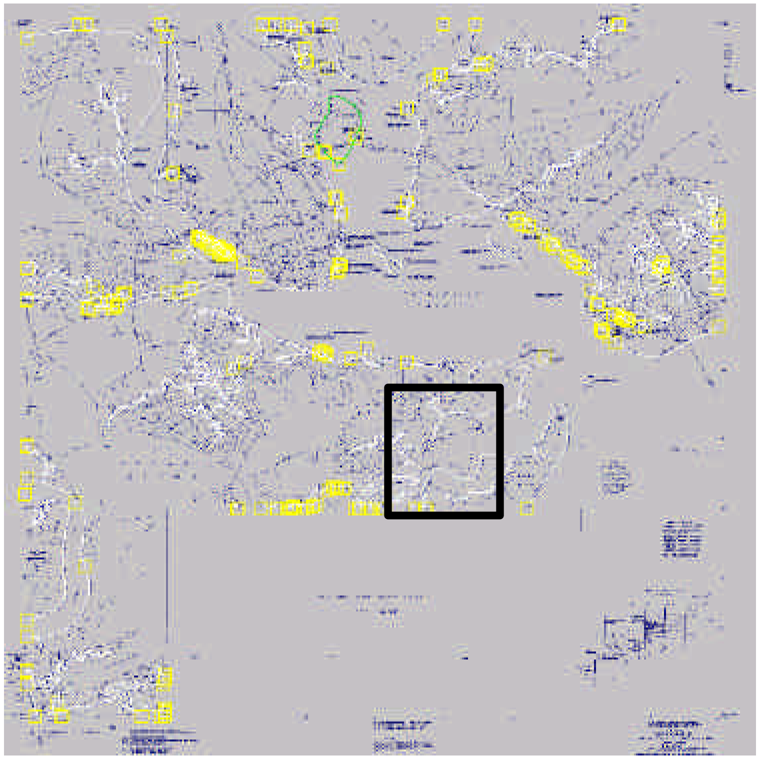
These represent a brief outline of some of the more common tools you will use during the vectorizing. Not all of the tools in the windows are highlighted here because some are not frequently used. As you become more familiar with the process, you will become more comfortable with not only what these do, but also when to use them.

Remember, there are often many different ways to solve an editing problem, so if one option does not work, there is another that probably will.

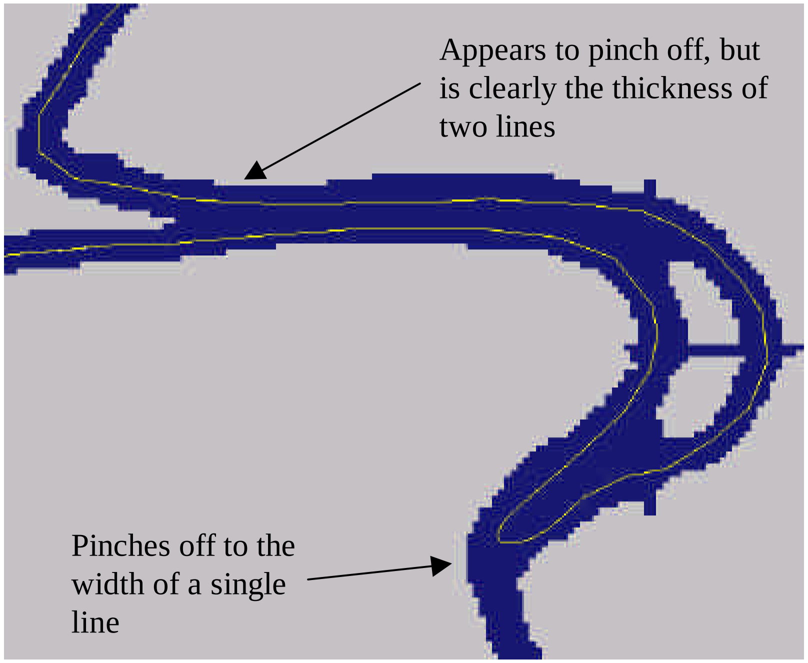
4D. An Exercise

You are now ready to begin an exercise that will incorporate all of the previous material. Set your screen to a **Fullview**, and use the **Extent** option to zoom into the following area shown to the right. Make sure you are at least as close as shown in the graphic below before beginning to trace this island. This may require an additional zoom or two.





In this exercise you will vectorize this entire island. When tracing, you will need to bear in mind the following:



- Trace all of the shoreline and any double-bank streams up until the point where they “pinch off” into a single line. (Consult the image to the right for an example.) You can use the tracer, manually add the arcs, or use a combination of the two. When manually adding arcs, zoom in close enough to properly lay the vector line in the middle of the rasters. The image illustrates a good zoom setting for this.
- Perform any necessary edits to remove dangles, move nodes and/or vertices, and straighten lines to ensure they fall as close to the middle of the raster lines as possible.
- Frequently zoom in closer to certain areas to get a better look at the raster lines, and back out to inspect the big picture.
- Ask questions!!

A Final Word: As you are tracing any of your coverages, it is imperative that you **<u>save frequently!!</u>** Saving every 15 to 20 minutes is a good idea. To do this, activate the **Edit Tools** window and use the **Coverage: Save** option from the **File** drop-down list. This is very important, as saving often will prevent having to retrace miles of shoreline that may be accidentally lost.

END

Chapter 5. Demo: Adding Attributes

5A. Coding the Arcs

Goal: To provide instruction on using the Table Manager

5B. Feature Codes

Goal: To provide a list of feature codes and examples

5A. Coding the Arcs

When you have finished vectorizing the island, you are ready to code the arcs with **attribute** information. Recall that this is data that relates various characteristics about the spatial features. There are several pieces of information that the software automatically places into the coverage's **Arc Attribute Table (AAT)**, so the only thing you will be adding is the **Feature Code**, or **F-code** for short. This tells the user what type of shoreline feature each arc represents.

Make sure that any editing that needs to be done to the vector coverage has already occurred before you add anything to the AAT.

You must first select the lines you wish to code. This can be done individually with the **Arrow** button from the **Feature Selection** window or with the **Polygon Selection** tool highlighted in Chapter 4C. Be careful to select only the lines corresponding to the island.

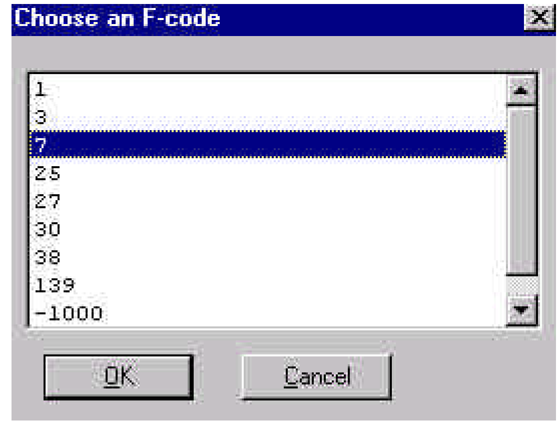
After the arcs are marked in yellow, end the selection phase by pressing **9** on the keyboard. Then make the **Edit Arcs & Nodes** window active and click on the button labeled **Table Editor**. A new window will appear labeled **Table Editor**. Notice that the **table** accessed by this is the AAT. (This is shown right below the menu bar.)

Examine the items of this table by clicking on the **Items** button. When you are done, click **Quit** to dismiss this table. Next examine the records in this table by clicking the **List** button. Note that the entries under the **F-Code** column are just zeros. Again click on **Quit** when you are finished.

ARC

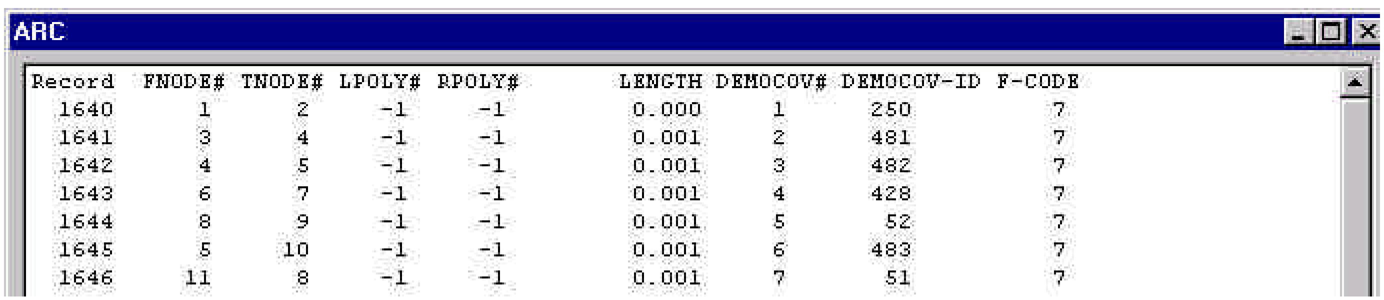
Record	FNODE#	TNODE#	LPOLY#	RPOLY#	LENGTH	DEMOCOV#	DEMOCOV-ID	F-CODE
1	1	2	-1	-1	0.000	1	250	0
2	3	4	-1	-1	0.001	2	481	0
3	4	5	-1	-1	0.001	3	482	0
4	6	7	-1	-1	0.001	4	428	0
5	8	9	-1	-1	0.001	5	52	0
6	5	10	-1	-1	0.001	6	483	0
7	11	8	-1	-1	0.001	7	51	0
8	12	13	-1	-1	0.002	8	447	0
9	10	14	-1	-1	0.001	9	484	0

To add the F-Codes, make the **Table Editor** window active. From this window, click on the button labeled **Calc.**



Another window labeled **Choose an F-Code** should now appear. From this window you will assign an F-code number for the various arcs that are selected. To begin with, all of the arcs will be labeled **7** for **Shoreline Plane of Reference (SPOR)**. This is the code used for standard shoreline. Click on the entry marked **7**. This will automatically add **7** to each arc's F-code field in the AAT.

To ensure that the F-codes are correct, click on the **List** button from the **Table Editor** window. This will list the entries in the ATT for each selected arc. The F-code field should contain only 7s. Click on the **Quit** button to close the AAT list and then **Dismiss** the **Table Editor** window.



ARC

Record	FNODE#	TNODE#	LPOLY#	RPOLY#	LENGTH	DEMOCOV#	DEMOCOV-ID	F-CODE
1640	1	2	-1	-1	0.000	1	250	7
1641	3	4	-1	-1	0.001	2	481	7
1642	4	5	-1	-1	0.001	3	482	7
1643	6	7	-1	-1	0.001	4	428	7
1644	8	9	-1	-1	0.001	5	52	7
1645	5	10	-1	-1	0.001	6	483	7
1646	11	8	-1	-1	0.001	7	51	7

At this point, all of the arcs are labeled as **SPOR**. However, there are many other types of lines in this coverage. If this were not a demonstration, you would now have to go back and code the other line types. For example, you would go back, identify, and select all of the **piers**. Once they are all highlighted, you would use the **Table Editor** and the **Calc** option to code the piers accordingly. A listing of all other types of lines and their codes is found in the following section.

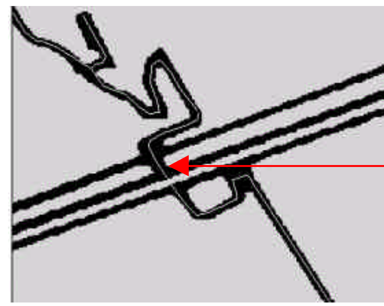
Note: In general, the best way to code the arcs is to first select all of them and code them according to the most prevalent type of line (usually Shoreline Plane of Reference.) Then, go back and change the ones whose codes are different, e.g., piers, jetties, etc.

5B. Feature Codes

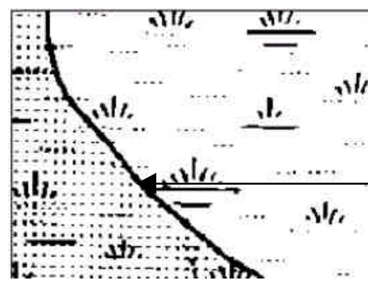
The F-codes can be grouped into three distinct categories: natural shoreline, man-made features, and general T-Sheet features.

A. Natural Shoreline:

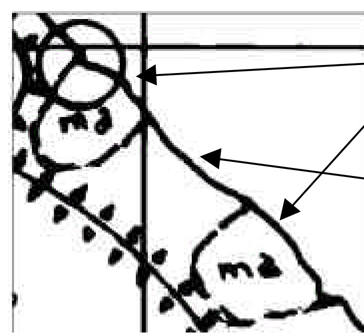
F-Code	Description
1	Approximate Shoreline: shoreline that is obscured by a man-made feature on the T-Sheet, e.g., shoreline underneath a bridge.
3	Apparent Shoreline: shoreline that is obscured by a natural feature such as marsh or other vegetation.
7	Shoreline Plane of Reference (SPOR): the delineation of the high-water line along natural shoreline; any unobscured shoreline



F-code 1:
Approximate
Shoreline



F-code 3:
Apparent
Shoreline



F-code 3:
Apparent
Shoreline

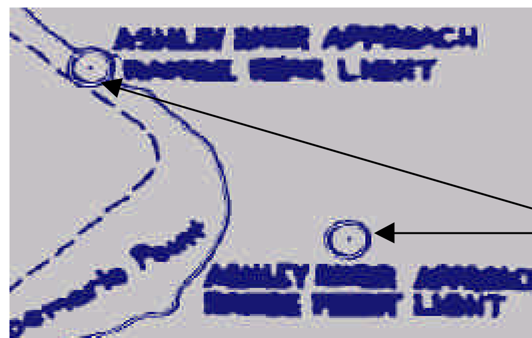
F-code 7:
Shoreline Plane of
Reference (SPOR)

B. Man-Made Features: most man-made features are self-evident from the code description, and many are often labeled as such on the T-Sheet

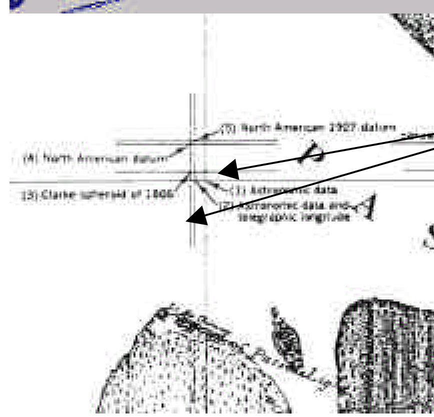
F-Code	Description
25	Dikes and Levees
27	Jetties, Breakwaters, Groins (labeled or unlabeled)
30	Piers, Ramps (above water), or Docks
38	General Class of Man-Made Objects that Form a Shore or Water Line: wells, oil platforms, wrecks, locks, dry docks, revetments, seawalls, wharves, marine railroads, or shorelines of seaplane bases or anchorages.

C. General T-Sheet Feature Definitions:

F-Code	Description
139	Control Points: cartographic features such as survey points and lights.
139	T-Sheet Correction Lines: lines which assist converting the projection of the map.



F-Code 139: Control Point



F-Code 139: T-Sheet Correction Lines

C. General T-Sheet Feature Definitions: (continued)

F-Code	Description
-1000	Map Extent Lines: solid border demarking the spatial limit of each T-Sheet, also called the neatline. (This will be drawn in by the user.)
-9999	User Added Arcs: any lines added by the user. Often used for the purpose of filling in gaps on raster lines.

END

Chapter 6. Procedures to Begin a New Coverage

6A. Starting a Coverage for the First Time

Goal: To provide an outline of how to create the coverage and add a neatline

6B. Continuing a Coverage

Goal: To provide instruction on how to clean the coverage.

6A. Starting a Coverage for the First Time

Before you begin tracing a T-Sheet for the first time, there are several steps you need to follow.

Navigate to the proper directory and make sure the grid is there.

At the **Arc** prompt, type the following command: **&run createnew.aml**. This program will create the coverage that will contain the linework. When prompted for the grid, click on it from the list. The name of your coverage will be the name of the T-Sheet followed by “cov” (e.g., t1234cov).

Once your coverage has been created you are ready to begin tracing. At the **Arc** prompt, type the following command: **&run trace.aml**. This starts the **ArcTools** application. From here you will need to

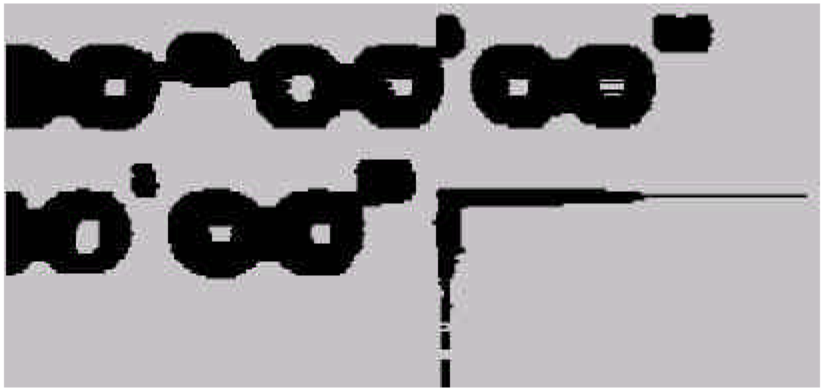
- arrange your windows
- add the grid and set the **Grid Environment** to your liking
- add the coverage and set the **General Environment** (nodes, dangles, pseudo-nodes) properties to your liking
- set the **Edit Environment** to the specified tolerances

I. Adding the Neatline:

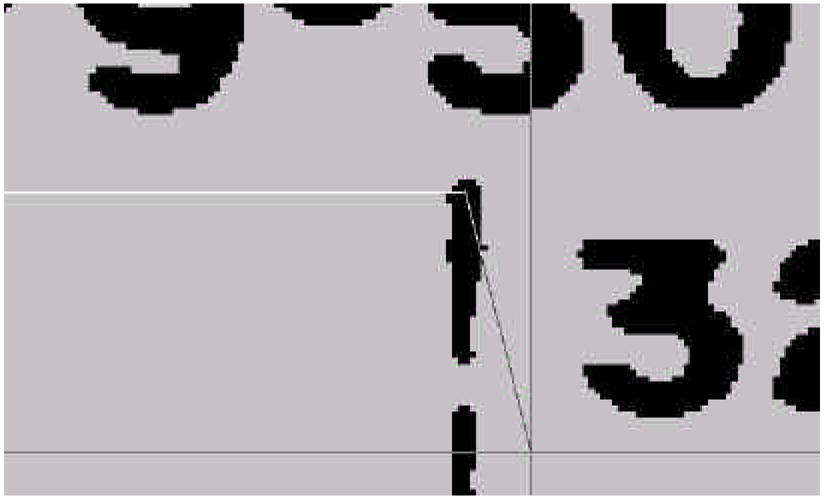
Before you begin tracing raster lines, you first need to manually add the ones that define the map extent. This will become the **neatline** of your map. The neatline will be defined by the four corner points of latitude and longitude on your grid.

The arrows in the graphic at right illustrate where to look for these coordinates.

Placing the neatline can be tricky because, in many cases, the latitude and longitude lines that “box in” the map are not entirely clear. In situations like this, you will have to make an approximation. Make sure that your screen displays a **Fullview** of your map. Then, with the **Extent** tool, zoom into each of the four corners of the T-Sheet. Ideally, you want to zoom in far enough to see if the latitude and longitude lines intersect to form a corner, as illustrated below.



When you have found such a corner, from the **Edit Arcs & Nodes** window, select the **Add** button to begin placing the neatline. You will need to first click on the **ARCEDIT** window to make it active. When you have placed the cursor to where you want the vertex, press **2**. At this point, when you move your mouse, you should see a line anchored at the vertex.



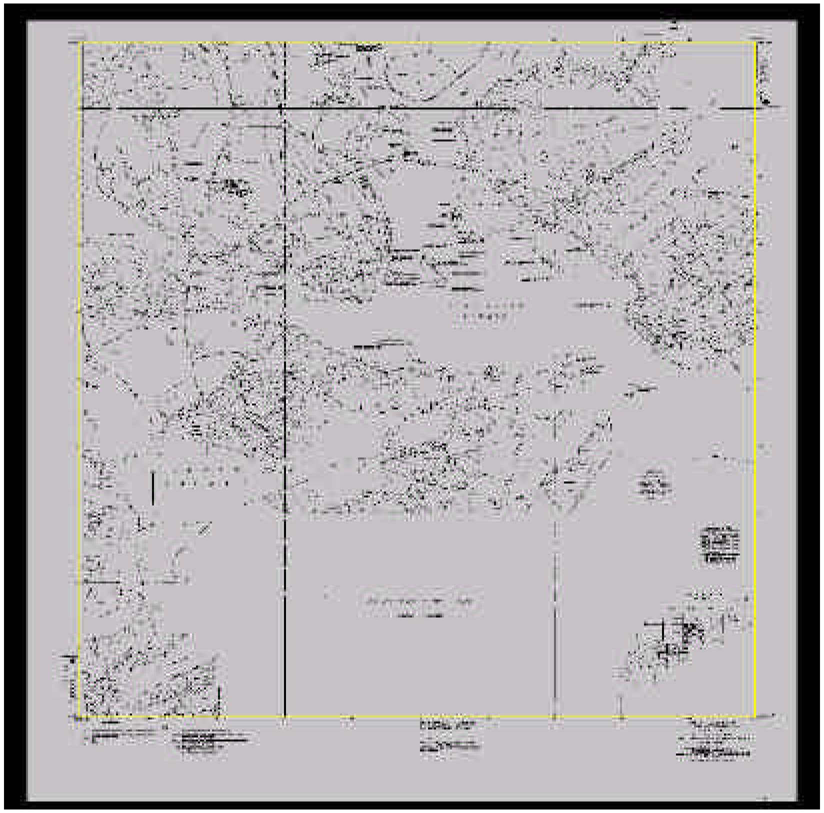
Now, set the window to display a **Fullview**, and then use the **Extent** tool to zoom into an adjacent corner. (Don’t worry if your line doesn’t appear to be at the corner point.) You should still have control of the line you began at the first corner. Place the cursor on the new corner point and left click to add the second vertex. You then should see part of the line from before, and now have the line anchored at the new vertex, as seen in the graphic to the right.

Repeat these steps to place the remaining vertices. You may have to adjust the zoom settings to align the neatlines as close as possible to the latitude and longitude lines.

When you come back to the location of the first vertex, place the cursor as close as you can to the beginning of the line, and press **2** to end the line. Then press **9** to end the process.

If your lines do not connect, you will have to move the vertex you just placed to eliminate the dangles. (Remember the neatline is like a box around the map area, so it must be a closed shape.) To take care of this, select the line, and click the **movev** button from the **Edit Arcs & Nodes** window. Click on the vertex to move, press **4,** and click the cursor over where you wish to place it. Then press **9** to end the process.

Redisplay your screen and set it to a **Fullview**. It should look like the graphic to the right, with a box surrounding the area that needs to be vectorized.



Once the neatline is in place, you may begin to trace the shoreline features using the procedures outlined in the previous sections.

Remember to always save your coverage every 10 to 15 minutes!!

Before you finish working on a coverage, always be sure to save it before you exit ArcTools!!

6B. Continuing a Coverage

Many of these coverages will take more than one day to trace. When you need to open a coverage that was previously started, before you run the **trace** program, you must first **clean** the existing coverage. This process will restore the coverage's topology, which essentially ensures that all the arcs are in their proper places and removes any miscellaneous graphics. The tolerances are preset so that small arcs like piers won't be automatically removed.

To run the cleaning program, make sure you are in the directory containing the proper coverage and at the **Arc** prompt type the following command: **&run cleanit.aml**. Select the name of the coverage from the pop-up window and click **OK**.

Once the coverage has been cleaned, you can then run the trace command, **&run trace.aml,** from the **Arc** prompt to begin vectorizing the lines.

It is also a wise idea to clean your coverage after you quit for the day. Just be sure to try to do it at least once a day, either before you begin or after you finish.

END

Chapter 7. Plotting Your Maps

7A. Using the Plotit.aml Program

Goal: To provide an outline of how to plot base maps, line maps, and color maps

7A. Using the Plotit.aml Program

Once your coverage has been fully vectorized, you will need to plot out hard copies. These will be used during the Quality Assurance/Quality Control (QA/QC) phase. Make sure your coverage has been saved, and then **Quit ArcTools** from the **File** option on the **Edit Tools** window.

From the **Arc** prompt, type the following command: **&run plotit.aml**. This will run the program used to plot your maps. After you enter the command, a pop-up window will open prompting you to choose what type of map to plot. There are three choices:

- **Base map**: a map of the grid you have been tracing. This is used to compare your linework to the actual shoreline features during the QA/QC process.
- **Line map**: a map of the coverage you traced that is compared with the base map during the QA/QC process. This is used to inspect the accuracy of the linework from the tracing steps.
- **Color map**: a map of the coverage after the attribute codes have been added. This is used to inspect the attribute coding accuracy.

When first using the **plotit** command, you will need to produce **one base map** of the grid and **one line map** of the coverage. (You will need to run a separate **plotit** command for each.) After the initial line map is reviewed, you may have to go back into **ArcScan (&run trace.aml)** to correct any errors and/or make any additions. For any corrections you make to the coverage, you will only need to print out line maps. No additional base maps will be necessary.

Once a line map has been finally approved, you will need to go into **ArcScan** and add all of the **F-codes**. Once the arcs have been coded, you will produce a **color map**. This will need to be checked as well, and if there are any corrections to be made, a new one will have to printed. An approved color map and its associated line map are the final results of the vectorization of a given grid.

You will then repeat the entire vectorization procedure for another grid.

END